VOLUME 81 NUMBER 7

# POWER

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STEAM GENERATION
POWER GENERATION
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AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
INSTRUMENTS & CONTROL
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POWER MISCELLANY

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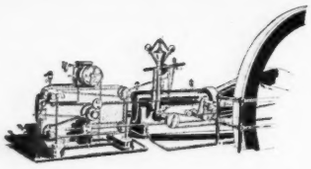
RIGHT DOWN YOUR ALLEY



### Groaning Valves Cured with StanoCyl "SH"

The power plant of a Central state prison had used a high grade cylinder oil for a number of years in lubricating the cylinders and valves of two Chuse, non-releasing, Corliss engines. The oil was entirely satisfactory until superheaters were installed which raised the temperature of the steam to 40° F. superheat at the throttle. With this change their trouble started. The valves on both engines "groaned". A number of different oils were tried with no relief until a Standard Lubrication Engineer recommended StanoCyl "SH".

**With StanoCyl the groaning was immediately reduced and, after a short period of operation, it disappeared entirely. These engines have operated for the past year on StanoCyl without any recurrence of the trouble.**

Whenever you are contemplating changes in your plant that involve lubrication call in your local Standard Lubrication Engineer. He may save you considerable worry, time and money by recommending the right lubricant at the start.

**NONPAREIL DIESEL OIL**
**STANOCYL CYLINDER OIL**
**STANOIL—SEVEN GRADES**
**SUPERLA GREASES**
**CALUMET COMPOUNDS**

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**"THE LUBRICATION ENGINEER"**

A booklet with the above title will be sent on request. It will tell you how the Lubrication Engineer works, what he can do for you, where you can find him and how you can profit both as a company and as an individual by using his services. A new, revised edition of this and other booklets listed below may now be obtained by writing Standard Oil Company (Indiana), 910 S. Michigan Avenue, Chicago, Illinois.

*"How to Cut Costs in Steam Turbine Lubrication"*
*"Steam Engine Lubrication"*
*"How to Cut Coal Handling Costs"*
*"Diesel Cylinder Lubrication"*
*"Diesel Engine Bearing Lubrication"*

# *"I had that same LUBRICATION PROBLEM just last week . . .*

# *Here's how WE SAVED THEM MONEY!"*

WHILE these two lubrication engineers are "in conference", note how the others are listening in—but that's not eavesdropping here. The lubrication information that one engineer gets and the experiences he has are the common property of all engineers in his office—in fact, throughout the whole Standard Oil engineering organization. That's just one reason Standard Lubrication Engineering Service is so effective.

Problems in lubrication are being solved daily by these engineers. The wealth of information they have accumulated and the exchange of ideas between them has given each one a background of knowledge *and experience* in industrial lubrication that's hard to beat. Try it the next time you have a particularly knotty problem of lubrication. Call your local Standard Oil office and tell one of the Lubrication Engineers you have a lubricating job he can't "lick". See what happens!

Remember this, you can't lose. Whether he's successful or not—it costs you nothing. The saving he does make is *yours*. From records of past service the odds are 100 to 1 he'll have many helpful, cost-saving suggestions to offer.

Copr., 1937, Standard Oil Co.

**STANDARD OIL COMPANY (INDIANA)**

**LUBRICATION ENGINEERING**

**THE RIGHT LUBRICANT • PROPERLY APPLIED • TO REDUCE COSTS**

A McGRAW-HILL PUBLICATION—ESTABLISHED 1882—PHILIP W. SWAIN, EDITOR **Power**

# Trouble Ahead!

THERE'S TROUBLE AHEAD, but not for everybody. This particular trouble story is about fuel—about the fuel you will be burning five or ten years hence.

Right here an acknowledgment is in order. The thoughts we shall present were suggested by a recent address of E. C. Payne, consulting engineer for Consolidation Coal. Because these ideas stand the test of practical logic, they now become our own and we present them as such in our own words, with due apologies to Mr. Payne.

Here, then, is our story: The depression had one good point; it saved operators the fuel troubles that go with heavily loaded boilers. Today these troubles come back to roost with a flock of young ones. Combustion equipment hardly good enough for a depression, never really right and now decrepit with age and neglect, must carry on to the limit. If you don't humor it with costly coal it will lie down and die on the job. Invalids must have their coddled eggs.

Next comes the awakening. Owners and operators agree on immediate modernization and start looking around for necessary equipment. What they discover is a sellers' market—equipment plants full of orders—slow deliveries.

Right here they face a dilemma. Delay in ordering may endanger plant operation, but one may sacrifice too much for speed, particularly if he doesn't take time to check his design from the angle of fuel markets and fuel selection.

However great the rush, no purchaser can afford to forget fuel-burning versatility, the plant's ability to burn practically any coal that is now, or in the future may be, the B.t.u. bargain of the moment. The owner of a "prima-donna" plant will pay and pay. Overfussy as to coal size, analysis, volatile and ash-fusion temperature, it will force him to do all his coal shopping on fuel's Fifth Avenue, where he'll pay plenty for his thermal units and where his suppliers will know that he can't duck placing the order, no matter how loudly he may yelp at the price.

So he'll lose money from the very start. As time goes on he may lose still faster. Premium coals will become scarcer. Real fuel bargains will come and go, but he will not be able to take advantage of them. The coal industry as a whole may get on its feet and stop selling at a loss. If so, the rising general price level will swell the differentials he must pay for his premium fuels.

The capitalized cost of carrying a 10 to 20% excess fuel bill for the next 20 years is something to think about. Why should any operator commit himself to this drain by overlooking the problems of fuel selection when he buys equipment? Far better, and far cheaper in the long run, to spend a few extra days in fuel studies, to enlist the aid of specialists in fuel use and fuel markets, to pay a little more for equipment that will handle the load with "any old fuel" and like it.

"The proof of the pudding is in the eating," but who wants to pay for a pudding or a new plant to discover for sure that it's half-baked? Don't buy a plant just to get experience.

Study present and future loads. Study fuels and fuel markets, present and future. Select equipment that can handle the loads always with cheap competitive fuels, and thereby avoid many years of enforced waste.

# A "Top" for 12th Street

***Basic principles of the superposition method of capacity increase are embodied in this 12,500-kw. "top" in Richmond, Va. Steam conditions are 850 lb. and 825 F.***

**By R. S. Reed**
*Mechanical Engineer,*
*Stone & Webster Engrg. Corp.*

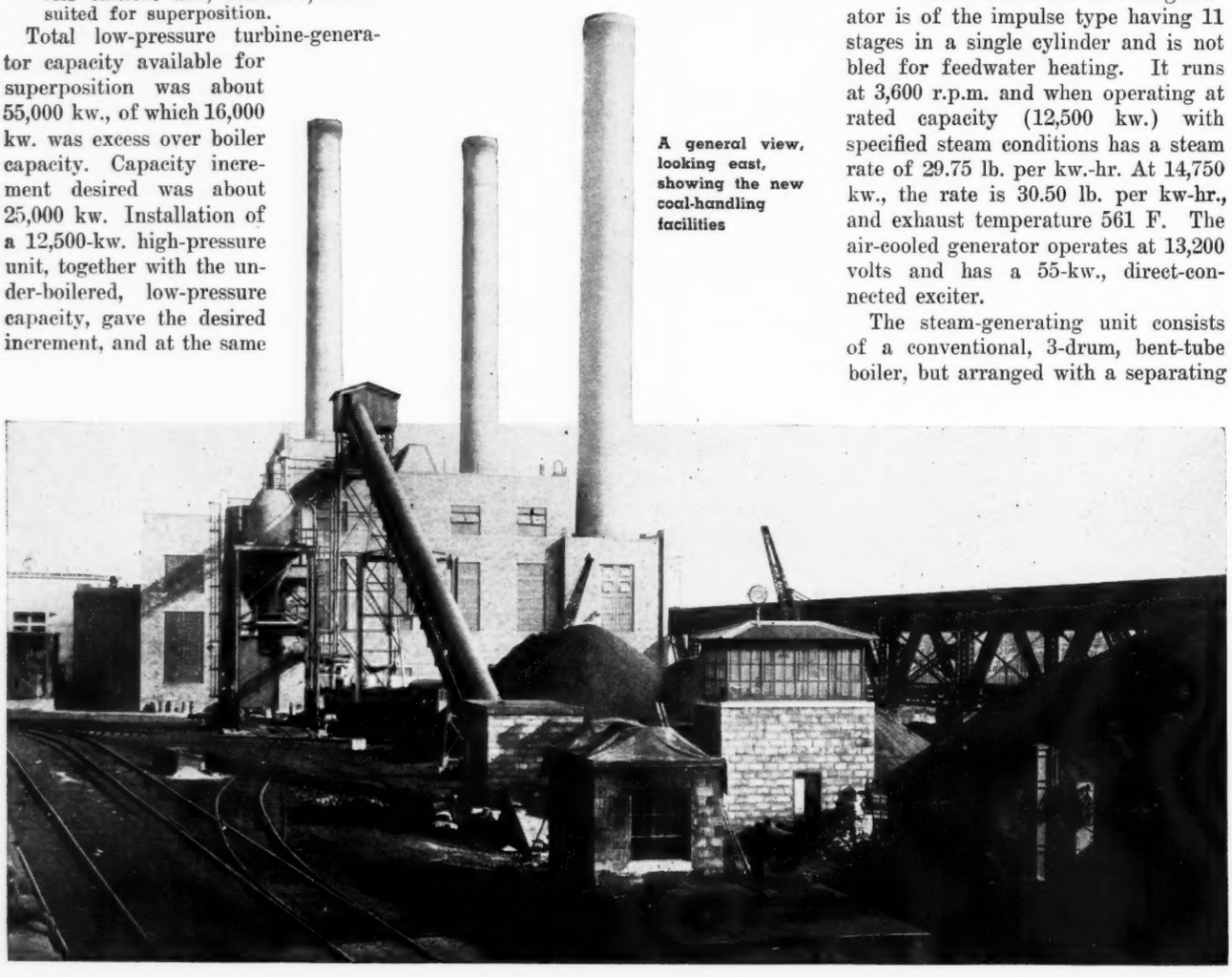
AMONG the first modern examples of superposition is the 12,500-kw. turbine and boiler in the 12th Street Station, Richmond, Va., of the Virginia Electric and Power Co. The installation has now been in operation for 6 mo., and practical operating expereience there is of value to larger installations now in course of construction. Briefly, reasons leading to the decision to superpose at Richmond were:

- There was a deficiency in electric generating capacity in the Richmond district.
- There was an excess of turbine-generator over boiler capacity in the existing plant.
- There is a definite limit to the supply of condensing water at Richmond.
- There were no material differences in construction or fuel costs between the site at Richmond and that at Norfolk.
- The Richmond plant was relatively less efficient and, therefore, better suited for superposition.

Total low-pressure turbine-generator capacity available for superposition was about 55,000 kw., of which 16,000 kw. was excess over boiler capacity. Capacity increment desired was about 25,000 kw. Installation of a 12,500-kw. high-pressure unit, together with the under-boilered, low-pressure capacity, gave the desired increment, and at the same time left remaining sufficent low-pressure capacity for future superposition of a second high-pressure unit. The combination also fitted well into the load curve of the Richmond district, and permitted high load-factor operation. A "top" throttle pressure of 850 lb. and a temperature of 825 F were selected as giving the desired exhaust pressure and temperature (220 lb. and 550 F). Throttle flow to the turbine under these conditions is 380,000 lb. per hr. Maximum flow, however, is 450,000 lb. per hr., sufficient to generate 14,750 kw.

Due to the reliability and high availability factor of modern boilers, it was decided to install only one steam-generating unit with a normal capacity of about 425,000 lb. per hr. and a maximum output of 450,000 lb. The saving in construction cost due to unit arrangement over the use of two boilers was in the neighborhood of $300,000. A unit system of pulverized-coal firing was adopted, using two mills per boiler.

As space was not available for the equipment in the present building, and as there was also insufficient steam-generating capacity for the present units, it was decided not to remove any of the present equipment, but to install the superposed turbine-generator and high-pressure boiler in an extension. The drawing is a general cross-section of the extension.



**A general view, looking east, showing the new coal-handling facilities**

### Turbine-Generator

The General Electric turbine-generator is of the impulse type having 11 stages in a single cylinder and is not bled for feedwater heating. It runs at 3,600 r.p.m. and when operating at rated capacity (12,500 kw.) with specified steam conditions has a steam rate of 29.75 lb. per kw.-hr. At 14,750 kw., the rate is 30.50 lb. per kw-hr., and exhaust temperature 561 F. The air-cooled generator operates at 13,200 volts and has a 55-kw., direct-connected exciter.

The steam-generating unit consists of a conventional, 3-drum, bent-tube boiler, but arranged with a separating

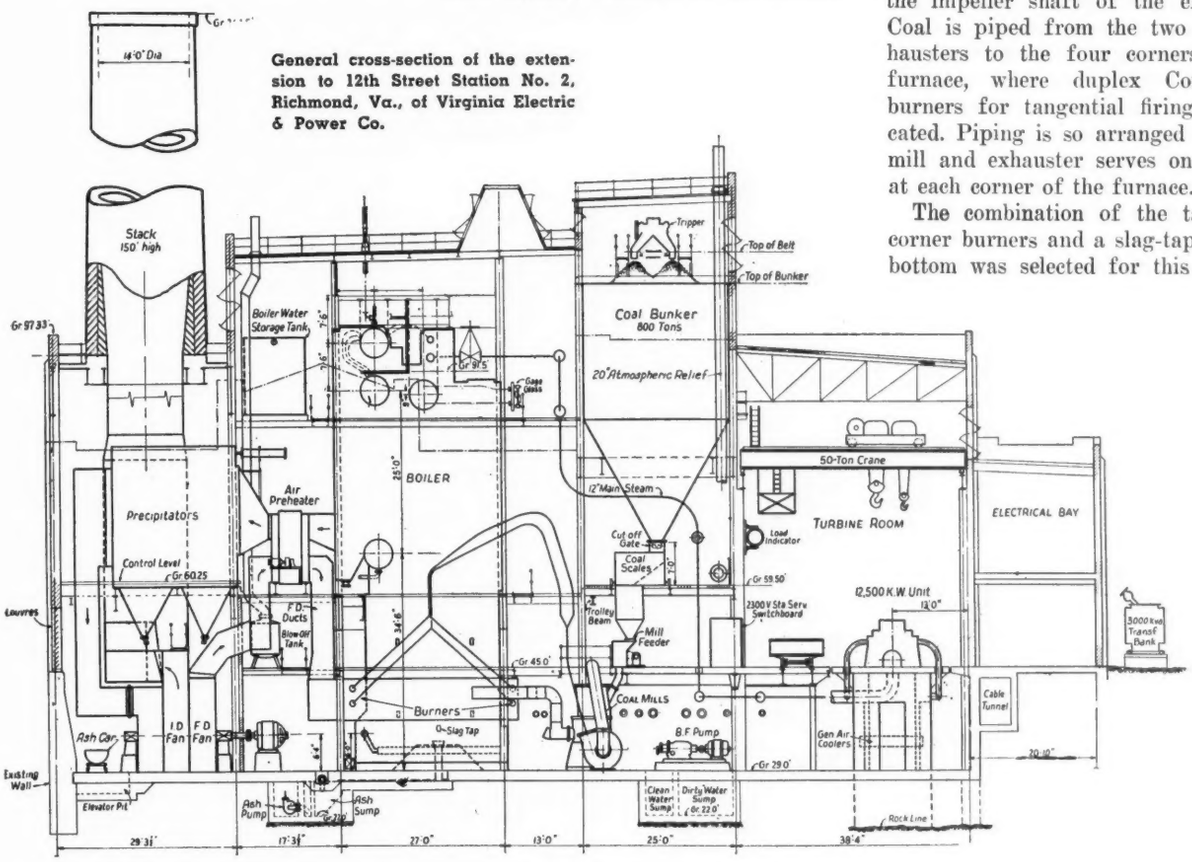
drum above the top rear drum. This is equipped with a steam scrubber in which steam generated in the boiler and waterwalls is led through a trough fed with incoming boiler feedwater. Any carryover in the steam from the boiler is scrubbed out by the cleaner feedwater, thus minimizing the total solid content of the saturated steam delivered from the dry drum.

Saturated steam passes through a 5-loop Elesco superheater in the first pass of the boiler. The upper section of the rear baffle forming the first pass is equipped with a row of automatically operated dampers, thermostatically controlled so that a portion of the gas may be short-circuited through the extreme upper section of the superheater elements as required to limit final steam temperature to a maximum of 835 F. The four sides and bottom of the furnace are provided with bare-tube waterwalls up to a furnace height corresponding approximately to the bottom-drum elevation, which is about 30 ft. above the furnace bottom. The front waterwall extends above this level to a height adjacent to the two upper drums. Furnace bottom fin tubes are installed so that adjacent fins butt together. They are covered to a depth of 5 in. over the entire furnace bottom with chrome ore to protect the tubes from erosive action of molten slag. The following amounts of heat-absorbing areas have been provided in this unit:

| | |
|---|---|
| Boiler ..... | 24,930 sq. ft. |
| Waterwalls .... | 11,060 sq. ft. |
| Superheater .... | 8,770 sq. ft. |

Furnace width is 30 ft., depth 20 ft., giving total furnace volume of 20,000 cu. ft. Heat release at 450,000 lb. per hr. steam generation is 28,420 B.t.u. per cu. ft. per hr.

Products of combustion leaving the boiler pass through two parallel horizontal Ljungstrom air heaters, each heater containing 16,100 sq. ft. of surface. On the basis of incoming air at 80 F, the air preheaters raise air temperature to 540 F and reduce the fluegas temperature leaving the air heater to 417 F, when the boiler operates at max. capacity. There is no economizer.




**General cross-section of the extension to 12th Street Station No. 2, Richmond, Va., of Virginia Electric & Power Co.**

### Coal Unloading and Conveying

The new station extension necessitated removing the original yard facilities for unloading, crushing, and elevating coal received in railroad cars. A new track hopper was installed approximately 365 ft. west of the end of the station, making possible an inclined belt conveyor, terminating above the top of the new station bunker. At its lower end, the required feeding and crushing equipment was installed to handle coal from the new track hopper to the belt or to a supplementary stocking-out belt conveyer for delivering surplus coal to the yard storage and reclaiming facilities.

At the upper end of the inclined belt conveyor, additional horizontal tripper and transfer belt conveyors were provided to distribute coal either into the new 800-ton bunker or onto the original tripper belt which serves bunkers in the 200-lb. boiler house.

These new facilities were installed and put into operation prior to completion of the new station extension to permit removal of the original track hoppers and feeders.

### Fuel Preparation and Burning

Coal is pulverized in two Raymond bowl-type mills, each having a capacity of 26,000 lb. per hr. Each mill is driven by a 200-hp. motor with the high-speed mill driveshaft coupled to the impeller shaft of the exhauster. Coal is piped from the two mill exhausters to the four corners of the furnace, where duplex Combustion burners for tangential firing are located. Piping is so arranged that one mill and exhauster serves one burner at each corner of the furnace.

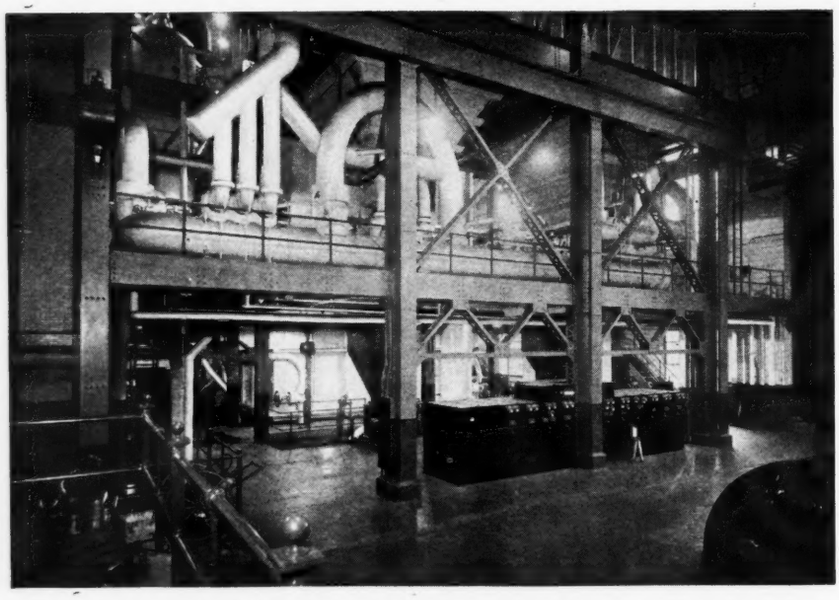
The combination of the tangential corner burners and a slag-tap furnace bottom was selected for this installation, and satisfactory operating results obtained to date, with coals having ash fusion temperatures up to 2,500 F, have justified this choice. Even during low-load periods, by increasing boiler output to 300,000 lb. per hr. for 2 hrs., no difficulty is encountered in obtaining a free flow of slag from the single tap opening at the side of the furnace bottom.

The following data are representative of the coal used:

| | |
|---|---|
| SOURCE: West Virginia-Pocahontas | |
| Moisture, % ..... | 2.02 |
| Volatile, % ..... | 17.32 |
| Fixed Carbon, % ..... | 75.88 |
| Ash, % ..... | 4.78 |
| B.t.u. as fired ..... | 14,572 |
| Ash-fusion point ..... | 2250 F |
| fluid point ..... | 2370 F |
| Grindability ..... | 98 |

### Ash Disposal

Slag is tapped from the furnace bottom through an opening midway on one side of the boiler. It is disintegrated in an Allen-Sherman-Hoff water-jet chamber and sluiced to an ash collection sump in the basement floor adjacent to the boiler. It is removed from this sump by two horizontal 6-in. Hydroseal ash pumps, one a spare. These pumps discharge through a 6-in. Ashcolite metal pipe line into the top of a 90-ton dewatering storage hopper directly over a spur track. Dewatered ashes can be dumped into a railroad car or, by a supplementary lowering spout, into trucks for local disposal.



**The boiler room, looking south, showing the new 425,000-lb. per hr., pulverized-coal-fired boiler**

Fly ash precipitated from a Cottrell dust eliminator is collected by air-swept suction valves and piping, and pneumatically conveyed through a 4-in. pipeline into a 25-ton fly-ash-collecting tank, from which it is discharged by a rotary dustless unloader into railroad cars or trucks.

### Draft Equipment

Forced- and induced-draft equipment consists of two units, each comprising one forced- and one induced-draft fan mounted on a common shaft between two bearings. Each unit is direct-connected to a 700-hp., 900-r.p.m., variable-speed, slip-ring motor. Each motor is controlled by a 13-point contactor with speed variation down to 50% of full-load speed. The forced-draft fan discharge is provided with a conventional louvre-type damper and the induced-draft fan is equipped with two sets of dampers; the louvre-type dampers placed ahead of the inlet box and radial-vane type control dampers adjacent to the inlet of the fan impeller. The latter dampers function from wide open to 25% closed only and are operated by the combustion-control system to adjust induced draft between successive speed steps. All three sets of dampers are connected to individual operators actuated by the combustion-control system. The correct selection of fan operating characteristics for these units involved careful analyses of system resistances at various loads to insure adequate fan capacities for both forced- and induced-draft fans at the various fixed speed points, at the same time keeping in mind possible reduction of power losses through damper adjustments. It has been demonstrated by operation that the type and arrangement of fans and drives are very satisfactory, possessing the inherent advantage of saving considerable space which was vitally necessary.

### Combustion Control

A Bailey automatic system of combustion control was provided to regulate the fuel and the primary-air supply to pulverizers, forced-draft damper position and fan speed in accordance with the demand for steam as indicated by changes in steam pressure. The control also readjusts forced-draft damper position and fan speed as required to maintain the steam-flow-air-flow ratio indicated on and regulated from the Bailey boiler-meter recorder. It also functions to adjust the induced-draft inlet vanes and further readjust, if necessary, the induced-draft inlet-box dampers as required to maintain a predetermined furnace draft.

Combined forced- and induced-draft fan sets were designed to produce induced-draft-fan capacity in excess of that provided by the forced-draft fan at any fan speed. Fan motors, of the slip-ring type, are provided with 13-point drum controllers for regulating the speed from 885 r.p.m. maximum down to approximately half this speed.

Changes in fan speed are obtained by electrical impulses originating from contacts operated by the forced-draft damper-control drive at predetermined maximum and minimum positions indicative of the need for a change in fan speed. Following each change in fan speed, the damper is automatically readjusted by a tachometer compressor connected to the fan shaft. This gives for any change in forced- and induced-draft a smooth characteristic curve closely following the theoretical system-resistance curves. Automatic control of fuel feed to the mills is obtained through the application of the standard Bailey control drives operating in parallel and connected respectively to a speed-changing device on the coal feeder and to the damper shaft at the inlet to the mill exhauster. Thus, rate of coal feed to the mill and primary air-coal mixture from the exhauster are automatically and simultaneously adjusted according to steam demand.

Supplementing the regular combustion-control equipment, accessory controls also are installed; first, automatically to shut off the supply of fuel from one mill by a high furnace-pressure trip device; second, automatically to cut in half the rate of coal feed to the mills should one draft-fan set or its related dampers accidentally be shut off; and third, automatically to close off the inlet and outlet dampers of either fan set in case that set should be suddenly shut down.

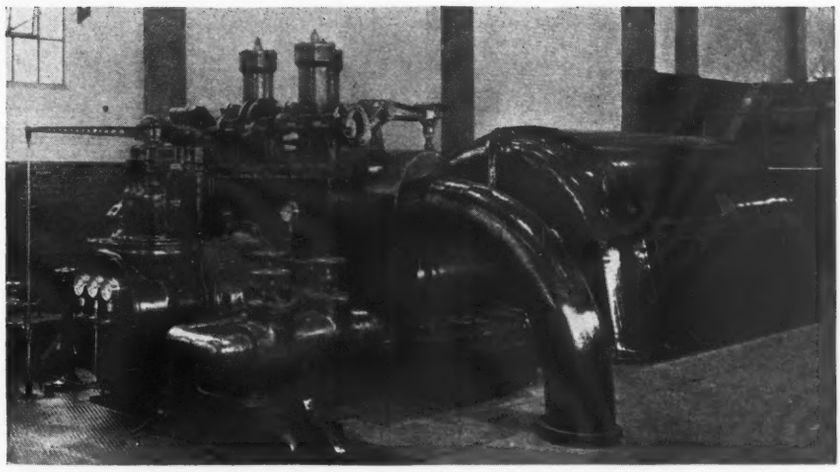
### Dust Elimination

The station is in the James River valley and close to the business section of Richmond, located on a fairly steep hillside. For this reason, it was important to minimize the emission of fly ash and dust from the stack. To accomplish this, a Cottrell electrostatic precipitator was installed between the air preheaters and the induced-draft fans. The precipitator is two sections in depth (direction of gas travel) and three in width having 42 parallel passages. Gas velocity does not exceed 9 ft. per sec. at maximum boiler steaming rate, and to avoid turbulence and insure an equal division of gas between passages, a perforated screen plate was installed ahead of the precipitator inlet, together with directional and splitting vanes in the gas ducts. As a result, the draft loss

between the preheaters and the induced-draft fan does not exceed 0.75 in. of water.

### Heat Balance

As is often the case with superposition, the nature of the low-pressure installation required some compromise with what would be a desirable heat balance for a completely modern installation. Auxiliaries in the low-pressure station are steam driven. Steam is bled from only one of the main units and that at only one point. The diagram shows the heat balance as finally adopted. Condensate from the 200-lb. condensing units is pumped into a deaerating heater, which gets its steam from the exhausts of the low-pressure auxiliary turbines, from the bleed connection on one of the main units, from continuous blowdown flash, and through a reducing valve from the 200-lb. system. A portion of the condensate is taken by a booster pump and passed through a heat exchanger in the high-pressure-boiler continuous-blowdown system before entering the deaerator. The 200-lb. boiler-feed pumps take water from the deaerator and discharge it into an open-type feed-water heater supplied with exhaust steam from the superposed unit and from the high-pressure turbines driving the new boiler-feed pumps. These pumps take their water from the high-pressure heater and discharge directly into the boiler at 380 F.



**Looking north in the turbine room toward the 12,500-kw. topping turbine**

Makeup water is taken from city mains and treated in a zeolite softener. Supplementary treatment, embodying use of phosphate with small quantities of sodium sulphite, is introduced into the feedwater system by conventional methods for automatically dosing water with these chemicals in proportion to rate of steam production.

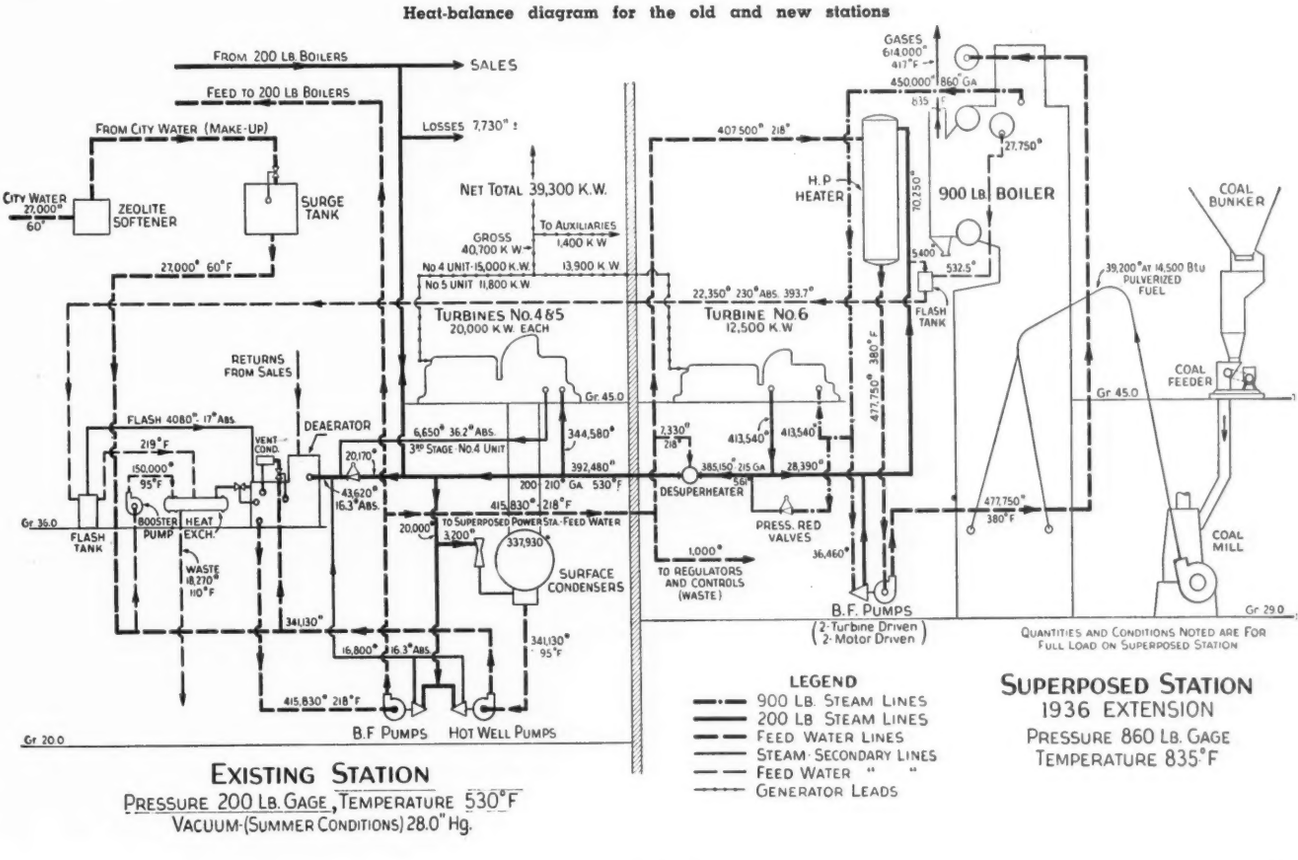
### High-Pressure Piping

High-pressure steam piping is fabricated from seamless, carbon-molybdenum steel tubing with wall thickness conforming to A.S.T.M. Specification A-158, P-1. Flanged construction has been limited to points where the piping connects to apparatus where valves are required, or where flowmeter nozzles have been introduced. Where flanges are employed, they are of forged carbon molybdenum steel of Sargol design.

The balance of the piping, including the high-pressure boiler feed, is fabricated from standard carbon-steel seamless tubing with wall thickness conforming to A.S.T.M. Specification A-106-34T, Grade A. Welding elbows and other fittings were used wherever possible with shop-fabricated welds, except where field welds were essential for convenient handling or erecting.

Chill rings were used on welded pipe joints over 2-in. diameter where the joints could not be welded on the inside. In all cases, the welding,

**Heat-balance diagram for the old and new stations**



## NEW EQUIPMENT INSTALLED

### Extension to 12th Street Station, Richmond, Va.

**Fuel Handling**

Coal-storage drag power shovel, 100 ton per hr....Sauerman Bros.
Stocking-out and reclaiming feeders to drag scraper, 100 t/hr. Stephens-Adamson Mfg. Co.
Main feeder, crusher and conveying system to station, 150 t/hr. Robins Conveying Belt Co.
Double-roll crusher, 150 t/hr.....Robins Conveying Belt Co.
Belt weightometer.....Merrick Scale Mfg. Co.
Bunker-coal weight scales (2 @ 18 t/hr. each) Richardson Scale Co.
Coal pulverizers, Raymond bowl mill (2 @ 26,000 lb. per hr. each) each driven by 200-hp., 1200-r.p.m. motor..Combustion Engrg. Co.
Coal burners, 4 duplex 8-in., Type T (2 per corner) Combustion Engrg. Co.

**Boiler and Auxiliaries**

Boiler, 1 bent-tube 4-drum, 4-pass type, design pressure 925 lb., operating pressure 860 lb. at superheater outlet. Heating surface: boiler 24,930 sq. ft., waterwalls 11,060 sq. ft., furnace volume 20,000 cu. ft.....Combustion Engrg. Co.
Apexiorizing .....Dampney Co. of America
Superheater, 1 Elesco, 5-loop, automatic-bypass-damper controlled, convection type, 835 F, 8,770 sq. ft. surface.Combustion Engrg. Co.
Air preheaters, 2 Ljungstrom horizontal, 32-in. heating elements, 16,100 sq. ft. each, final air temperature 540 F Combustion Engrg. Co.
Safety valves.....Consolidated Ashcroft Hancock Co.
Blow-off valves.....Cochrane Corp.
Soot blowers.....Diamond Power Specialty Corp.
Water columns.....Diamond Power Specialty Corp.
Boiler feedwater regulators (Copes).....Northern Equipment Co.
Excess-pressure regulators.....The Swartwout Co.

**Turbine and Auxiliaries**

Turbine-generator, 12,500 kw. at 80% p.f., 11-stage, 3,600-r.p.m.; generator 3-phase, 60-cycle, 13,200-volts, 0.8 p.f.; direct-connected, 55-kw., 250-volt exciter.....General Electric Co.
Generator air cooler, 2-section, 4,080 total sq. ft. surface air cooler, 35,000 cu. ft. per min. outlet air temperature not over 40 C., water 250 g.p.m. at 80 F inlet temperature..General Electric Co.

**Draft System**

Draft fans, 2 sets, each set consisting of 1 forced-draft element, 78,000-c.f.m. vs. 10 in. and 1 induced-draft element, 155,000 c.f.m. vs. 14 in. Each set direct-connected to one 700 hp., 900-r.p.m. slip-ring motor, 13-point speed control.....B. F. Sturtevant Co.
Fly-ash precipitator, Cottrell, 3-units wide, 2 sections deep, total 42 ducts wide, 75,000 volts, 90% dust removal....Research Corp.
Chimney, radial brick, 14-ft. dia. at top,, 150 ft. high above roof mat..... Rust Engrg. Co.

**Ash Disposal**

Hydrojet furnace slag disintegrating asd sluicing, disposal piping and 90-ton steel dewatering and storage tank Allen-Sherman-Hoff Co.
Fly ash, collection and disposal from hoppers under last pass boiler and Cottrell precipitator, including Hydroveyor vacuum-system piping—25-ton storage tank and dustless unloading equipment .....United Conveyor Corp.

**Feedwater Facilities**

Deaerating heater, 1 open, direct-contact type, maximum capacity 600,000 lb. per hr. Water outlet temperature 218 F, inlet steam pressure 2.0 gage, 4000-gal. storage capacity....Cochrane Corp.
High-pressure heater—direct-contact rain-type vertical tank heater —maximum capacity 500,000 lb. per hr., temperature inlet water. 218 F. temperature outlet water 386.9 F. or within 1 deg. of steam temperature. Normal steam pressure 200-lb. gage. Shell, 1¼ in. thickness Armco iron plates. Dimensions 77 in. dia. x 27 ft., 2 in. vertical height. Water-storage capacity, 4,000 gal. Westinghouse Elec. & Mfg. Co.
Blowdown heat exchanger—single-pass straight-tube approx. 20,-000 lb. per hr.....Griscom-Russell Co.

**Pumps**

Boiler-feed pumps, 2 motor-driven, with 500-hp., 3,600-r.p.m. constant-speed motors, and 2 turbine-driven with 555-hp. Terry turbines, 3,600-r.p.m. variable-speed. Each pump. Cameron 6-stage normal capacity, 350,000 lb. per hr. water at 375 F, total head 2,100 ft.....Ingersoll-Rand
Condensate booster pump, 1 300-g.p.m., 30 ft., 3-hp., 1,200-r.p.m. motor.....Worthington Pump & Machinery Corp.
House service pump—1, 2-stage centrifugal pump, 1,500 g.p.m., 310 ft., 150 hp., 1,800-r.p.m. motor Worthington Pump & Machinery Corp.
Clean-water sump pump—1, 4-in. vertical submerged centrifugal pump 150-g.p.m., 125 ft., 15-hp., 1,800-r.p.m. motor Goulds Pumps, Inc.
Dirty-water sump pumps—2, Cameron automatic self-priming centrifugal pumps and integrally mounted 7½-hp., 3,600-r.p.m. motors, 200-g.p.m., 100-ft.....Ingersoll-Rand
Slag-ash handling pumps—2, 6-in. Hydroseal, horizontal ash pumps and V-belt drives to 75-hp., 1,200-r.p.m. motors Allen-Sherman-Hoff Co.
Phosphate and caustic-solution pumps—3, 1-in. horizontal single stage centrifugal pumps and direct-connected 1-hp., 1,750-r.p.m. motors.....Worthington Pump & Machinery Corp.
Oil-filter pump—1 rotary oil pump ½-in., 270 gal. per hr. with direct connected ½-hp. motor.....S. F. Bowser & Co.

**Tanks**

Boiler blow-off.....R. D. Cole Mfg. Co.
Boiler-water storage—two 8,225 gal.....Connery Construction Co.
Flash tanks (2).....Grinnell Co., Inc.
Phosphate feed-pressure tank.....Grinnell Co., Inc.

**Regulating and Control Equipment**

Steam-pressure reducing valves and control.....Swartwout Co.
High-pressure heater water-level control.....Swartwout Co.
Make-up steam-pressure reducing to deaerating heater Swartwout Co.
Main-turbine exhaust-pressure regulator.....Bailey Meter Co.
Combustion control, including draft fans and coal feeders Bailey Meter Co.
Phosphate feed to boilers.....Bailey Meter Co.
Desuperheating equipment, 200-lb. steam main—20-in., 500,000-lb. per hr...Republic Flow Meters Co. (Smoot Engineering Division)
Superheater bypass damper control.....Hagan Corp.
House-service water-pressure regulator....Mercon Regulator Co.

**Instruments**

Indicating pressure gages.....Crosby Steam Gage & Valve Co.
Recording pressure gages.....The Bristol Co.
Indicating glass-stem thermometers Taylor Instrument Co's.; Consolidated Ashcroft Hancock Co.
Recording thermometers .....The Bristol Co.
Flowmeters .....Bailey Meter Co.
Recording pyrometer.....Leeds & Northrup Co.
Recording $CO_2$ meter.....The Hays Corp.
Indicating draft gages.....The Hays Corp.
Smoke density recorder.....Bailey Meter Co.
Recording potentiometer for condenser tube leakage Leeds & Northrup Co.
pH electrometer.....Wilkens Anderson Co.

**Piping, Valves and Fittings**

900-lb. steam and boiler feedwater and 200 lb. steam piping, shop fabrication and erection.....Grinnell Co., Inc.
Balance of piping, shop fabrication.....Grinnell Co., Inc.
900-lb. steam gate valves, 900-lb. water gate valves, 250- and 300-lb. steam and water gate valves .....Chapman Valve Mfg. Co.
Globe valves, 1500-900-600-400-lb. standards, steam and water Edward Valve & Mfg. Co.
Gate and globe valves, 125-lb. services..Reading-Pratt & Cady Co.
Non-return valve, 900-lb. steam.....Schutte & Koerting Co.
Safety valves, 200-lb. steam header Consolidated Ashcroft Hancock Co.
Safety valves, 200-lb. turbine exhaust lead..Atwood & Morrill Co.

**Miscellaneous**

4-motor, 50-ton traveling crane.....Whiting Corp.
Turbine-oil filter equipment.....S. F. Bowser & Co., Inc.
Steel-plate air ducts and smoke flues....Connery Construction Co.
Air compressor for control equipment.....Ingersoll-Rand Co.
Heat insulation.....The Philip Carey Co.

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whether done in shop or in field, was stress-relieved. Studs or bolts for the high-pressure steam and water pipe flanges conform to A.S.T.M. Specification A-96-33, Class C, machined 12 threads per inch over entire length.

High-pressure steam valves are cast steel of the following characteristics:

PHYSICAL

| | |
|---|---|
| Tensile strength..... | 80,000 lb./sq. in. |
| Yield point..... | 50,000 lb./sq. in. |
| Elongation in 2 in.... | 22% |
| Reduction in area.... | 40% |

CHEMICAL

| | |
|---|---|
| Carbon ..... | 0.20 - 0.35 |
| Manganese ..... | 0.65 - 0.85 |
| Phosphorus ..... | 0.05 max. |
| Sulphur ..... | 0.05 max. |
| Silicon ..... | 0.30 - 0.45 |
| Molybdenum ..... | 0.40 - 0.60 |

Seat rings are of Nitralloy and disks of nitrided alloy steel.

### Operation

As is usual with installations embodying progress in the art, a number of difficulties were encountered, none of a serious nature. Vibration of the main unit was experienced when the field current was put on, although the mechanical balance was perfect. Superheat was low due to air infiltration. Water hammer developed in the 200-lb. open heater. These difficulties have all been remedied.

Slag is tapped from the furnace once in 48 hr. At the start of tapping it is necessary to operate the boiler at from 275,000 to 300,000 lb. per hr. After flow has started, boiler output may be reduced to from 225,-000 to 250,000 lb. per hr. Experiments have been conducted on coals with estimated fluid temperatures up to 2550 F, without difficulty. Heat-absorbing equipment has operated for one month at about 90% efficiency.

The station was designed and built by Stone & Webster Engrg. Corp.

# N. Y. Municipal Building Modernizes Its Elevators

***By replacing the elevators in New York City's Municipal Building, passenger-carrying capacity has been more than doubled, and office space obtained equal to one floor in the building***

THE PHRASE, "A woman is as old as she looks and a man as old as he feels," might be paraphrased to read, "A building is as old as its elevators." You can't have an up-to-date building without modern elevators. The best part of this is that such equipment pays big dividends in improved elevator service, increased capacity, reduced power and operating costs and increased income from rentals. New York City building engineers, realizing this, have modernized the city's Municipal Building elevators.

This building, a 25-story structure with a 12-story tower, went into service about 25 yr. ago. It is still an excellent example of modern skyscraper architecture, but its elevators had become entirely inadequate and out-of-date. First, building population, both permanent and transient, had increased far beyond that anticipated when the building was designed; second, even though there were more elevators than required for a modern office building of given size, they were inadequate because of slow car speed, manual control, manually operated hoistway doors and car gates, and difficulties in keeping the equipment in good condition. All of this has been eliminated by installing modern elevator equipment. Badly needed additional office space, approximately equivalent to one floor, has been made available by the change and is now occupied.

The building arches over Chambers Street, so that on the ground floor it is equivalent to two buildings, each with entrances and elevator corridors that must be served with local and express elevators. Even though floors join above the third story, two separate elevator corridors must be provided up through the 25 stories. In each half of the building are 16 elevators, 8 on each side of the corridors, one-half of which run local from the first to the 14th floors and the others express from 14th to the 25th floors. An additional elevator runs from the 25th to serve 12 stories in the tower.

Old elevators, designed for 3,000-lb. capacity, operated at 500 ft. per min., with manual car-switch control. Cars and hoistways were of open metal grille-work construction, a design no longer accepted by the city's building code. Elevator machines were tandem-geared, drum-traction, with 48-in. diameter drums having single helical U-grooves. Each of the 6 hoist ropes from a car made 2.5 wraps around the drum and then went to the counterweights. As the drum turned, ropes traveled along it very much the same as a nut on a bolt thread.

**Fig. 1—Automatic scheduling of local and express cars is centered on a double-faced pedestal in the center of the ground-floor corridor**

An interesting feature of these elevators was their long hoist-rope life. Ropes, which went into operation in 1913 were not changed on any elevator until 1931, were Roebling $\frac{5}{8}$-in. traction steel, Warrington construction. One of the first sets of ropes removed had gone 176,000 mi. A sample taken from the worst worn section of the set tested 20,188 lb., 85% of its catalog strength. Reduction of metal due to wear was only 6% and the ropes showed no signs of internal corrosion and were still in safe condition.

Ropes removed in 1932 had operated nearly 190,000 mi. and showed slight but not dangerous signs of fatigue. Considering all factors that influence elevator-rope life, the reason for extremely long life of these ropes must be found in the large diameter of the drums (48 in.), their grooving, and the number of turns on them.

Tandem worm gears comprise two worms on the same shaft, with two gear wheels all meshing together. Since the worm thrust is counteracted in the meshing worm wheels, theoretically thrust bearings are not required with such gears. When they wear, however, backlash in them may permit a very objectionable up and down motion of cars when they stop, as was the case in the Municipal Building. Worms and gears had become so badly worn that replacement would have been necessary at a cost of about $1,500 for each machine.

Machines were equipped with a mechanical brake on the drum and one step of dynamic braking in the control. It never was possible, even when new, to get this combination adjusted to give a smooth stop. As wear increased, conditions became worse. Not only was stopping at floors abrupt and jerky, but operation of the equipment was very noisy. These conditions combined with shortcomings of the control made

it difficult for operators to land the cars at the floors, and a great deal of jerking of cars at landings resulted, with a consequent slowing up of elevator service and increased wear on equipment.

All elevator machines, local and express, were located above the 25th floor, so that eight hoistways on the local cars above the 15th floor, in each half of the building, served only as passageways for car and counterweight cables. In addition, corridors between the banks of local cars on these floors were only so much waste space that could be converted into desirable office space.

These conditions led to a decision to replace the elevators with modern equipment. Otis Elevator Company obtained the contract. No part of the old elevator equipment, except the hoistways, has been retained, and these have been totally inclosed and fireproofed. Elevator machines for the 16 local cars have been installed on the 16th and 17th floors. These changes allowed converting the local-car hoistways above this level and one-half of each of the corridors into office space, a combined area about equal to one whole floor.

Cars are comparatively small, making it quite a problem to move large pieces of office equipment from one floor to another. This problem has been solved by throwing two express-car hoistways into one and installing the largest car that would go into the space. This car is wide and comparatively shallow with wide center-parting double-leaf hoistway and car doors. It is therefore not only suitable for handling large objects, but also the large groups of people that at times come into this building. This car, which can serve all floors in the building, will easily carry 42 passengers, compared to 14 in the other cars. It has a capacity of 6,500 lb., at 800 ft. per min., and is operated by a unit - multi - voltage, signal - control, micro-leveling, double-wrap, traction machine with eight $\frac{3}{4}$-in. hoistway ropes, powered by a 125-hp. motor.

All of the old cars terminated at the ground floor. In hoistway No. 1, one new local car has been extended into the sub-basement to give elevator service to a frequently-used record storage room. Conditions for elevator service in the basement and sub-basement of this building are difficult because it is a terminal for three subway lines.

### Ventilation

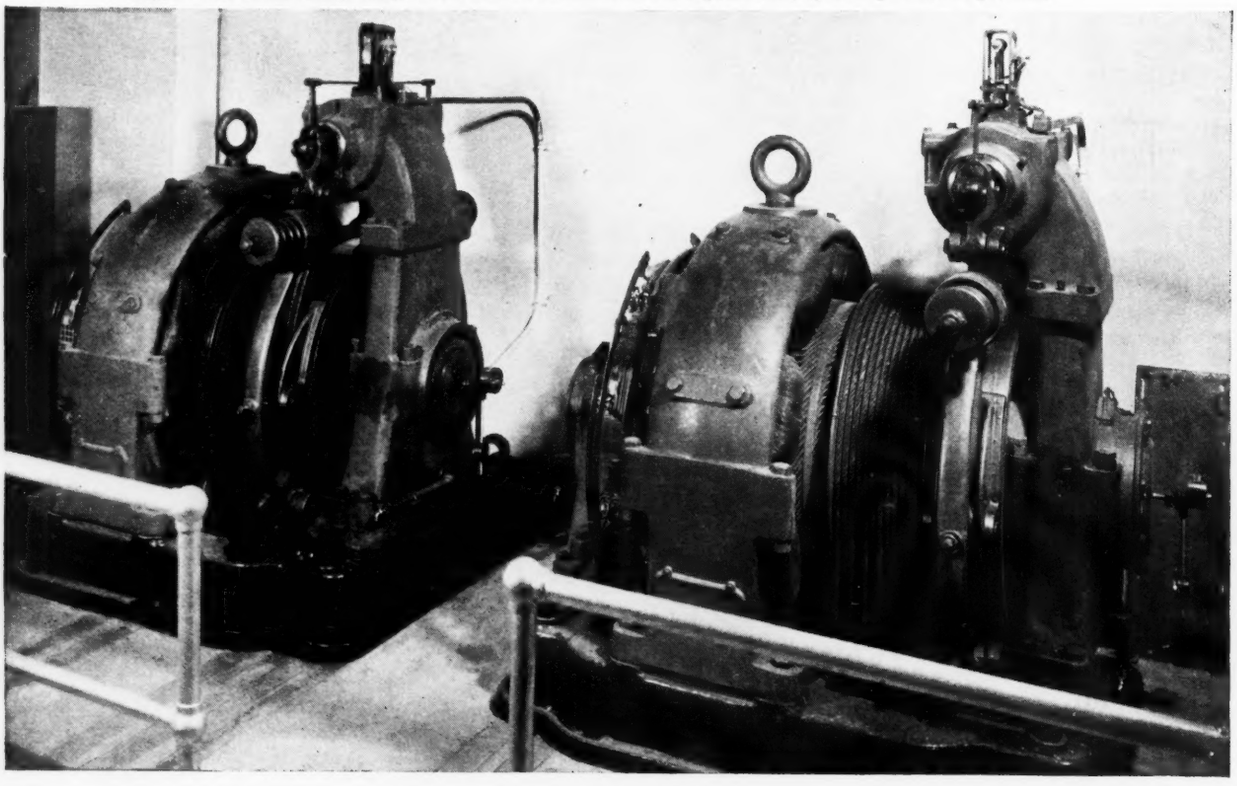
Forced ventilation is provided in all the machine rooms for warm weather. Air is discharged into the rooms along the floors, and taken out through ducts, intakes to which are located just above the principal pieces of equipment.

With the exception of the large car, all elevators have standard direct-traction, double-wrap, micro-leveling machines, Fig. 2, designed to operate 3,000-lb. capacity cars at 800 ft. per min., with unit-multi-voltage signal control. With this system, operation is entirely automatic from pushbuttons in the car and at the landings, with the exception of car starting. This is done by moving a small lever to the start position, after which hoistway and car doors close, the car then starts and goes to the first floor for which a button has been pressed, stops, and doors open automatically.

On the operator's panel in each car, in addition to the start lever, are a bank of pushbuttons, one button for each floor served; red, green, and white signal lights and a single-stroke bell for the automatic-scheduling system; a non-stop switch to bypass floor calls made from landing buttons in case of a full car; a safety switch to open the potential-switch circuit, in order to stop the car in case of emergency; a micro-switch which permits operating the car at micro-leveling speed; and other switches for car lights and fan, starting and stopping the motor generator set and other functions essential in safe and convenient operation. Each car also has an electrical floor indicator, and a telephone for communication between operator and the starter.

Control for these cars has an improved type of selector provided with what is known as an advancer panel. All the mechanically operated contacts that were on top of the old-type selector are on the travelling crosshead of the new design. When the car-starting lever is moved to the start position, the advancer panel immediately moves to the floor position on the selector where the next stop is to be made, provided this stop is within about 50

Fig. 2—Two of the double-wrap, direct-traction machines on the express cars, operating at 800 ft. per min.



ft. of where the car is standing. The advancer panel closes the circuit for the floor lantern to indicate to waiting passengers the next car that will stop at that floor. After the advancer panel has picked up the floor call no other car can take the signal. Thus, a positive signal is given to waiting passengers of the approaching car well in advance of its arrival. Closing the doors starts the car and when the selector crosshead catches up with the advancer panel, it slows down and stops the car at the floor.

If the next call is more than 50 ft. away from where the car is located when the call is made, the advancer panel will move a distance on the selector corresponding to about 50 ft. in the hoistway. It will then advance with the selector crosshead until a floor signal is picked up, then will stop and light the floor lanterns. The car is then stopped when the selector crosshead catches up with the advance panel, as previously explained.

Both local- and express-car banks are provided with a non-sequence, automatic-scheduling system. With this system, cars do not necessarily operate on a sequence schedule, for the first car arriving at a terminal landing gets the next start signal. This system has the advantage that if a car is delayed on its trip, the next car immediately replaces it on the schedule to prevent service delays that might otherwise occur.

Signals for dispatchers are grouped on a double-faced pedestal in the center of the ground-floor corridor, Fig. 1. On one side of this panel are signals for express cars and on the other for locals. These panels include columns of lights that show the position of each car in the hoistway and direction indicators giving direction of car travel. Other columns of lights show the floor on which passengers have signaled cars and the direction of these signals. Other indicators also show when a car is running non-stop, when cars are signaled to leave terminal landings and when they leave, and which cars are in service.

Control of the automatic-scheduling system is also on the dispatcher's panel, which provides for several systems of operating the cars. Normally, local cars are scheduled to answer all calls between the 1st and 15th floors and the express cars stop at 15th to 25th floors. During peak traffic periods, some of the local cars can be scheduled to operate from the 1st to 7th floors, and the remainder to run express to 8th and local to 15th. A similar schedule can be selected for the express cars serving 15th to 25th floors. Switches are provided on the dispatcher's panel to automatically schedule cars when they are operating in any of these arrangements, and other switches adapt floor signals to any of these systems of operation.

Three of the elevator banks and the tower elevator have been modernized and work is in progress on the last bank. Because of their higher speed and automatic operation, new cars can handle more than double the number of passengers carried by the old ones.

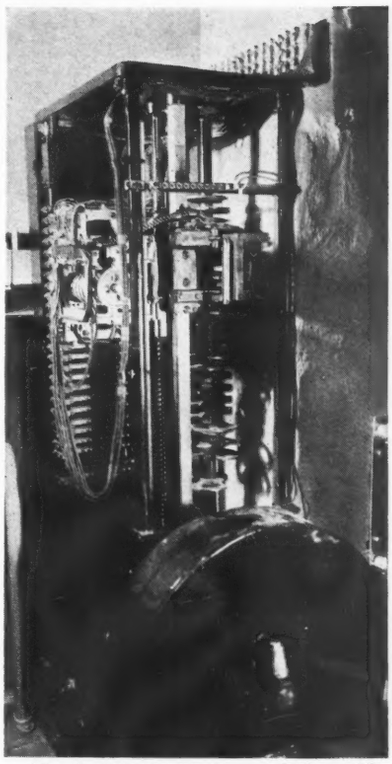
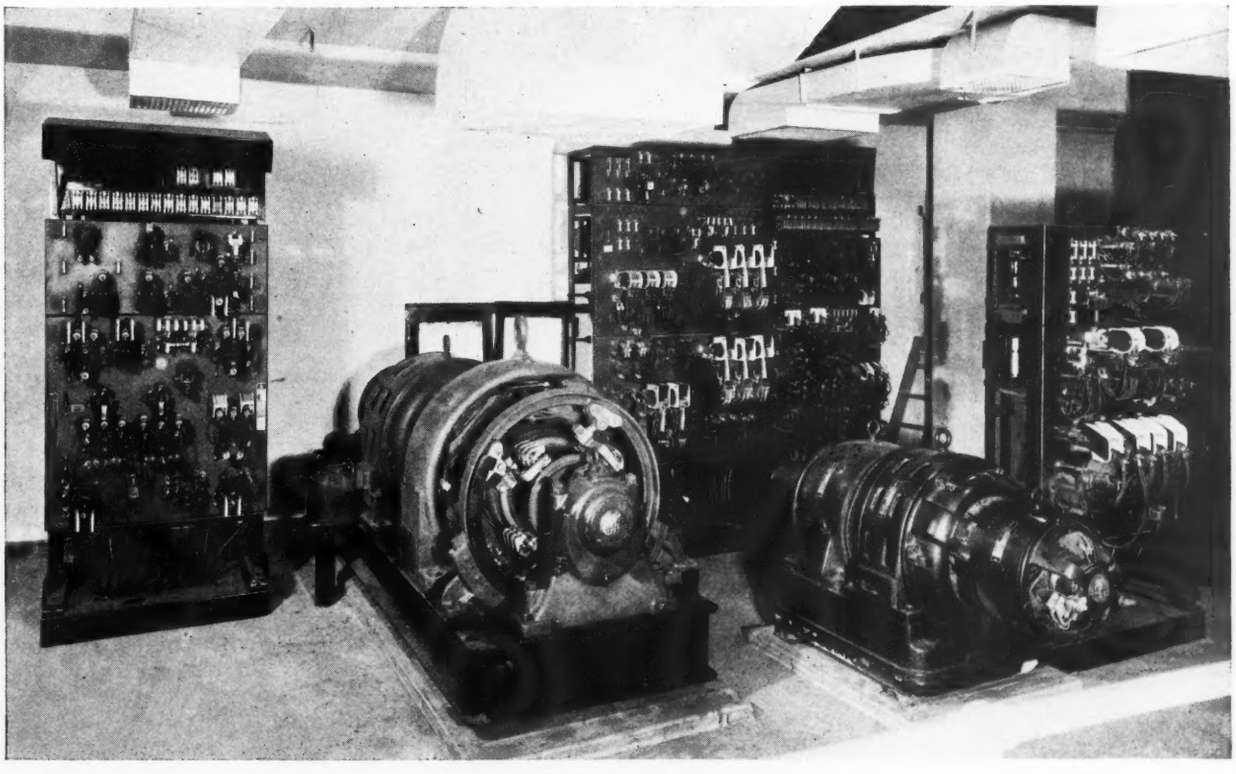


**Fig. 3—Selector is of new design with all switches mounted on the travelling crosshead**

When all the cars are modernized, congestion of passengers at landings, so prevalent in the past during morning, noon and evening peaks, will be entirely eliminated. In many other ways, elevator service will be so improved that it will be raised from what would be considered almost intolerable to excellent.

**Fig. 4—On the right, control and motor-generator for the large elevator machine; standard equipment on the left**



# Weirton Top Saves 500 Tons a Day

***850-lb., 820-F superposed plant at Weirton Steel saves 15,000 tons of coal per month. Installation includes two 400,000-lb.-per-hr. boilers and a 10,000-kw. turbine***

**By J. H. Strassburger**
*Combustion and Fuel Engineer, Weirton Steel Co., Weirton, W. Va.*

FOR ABOUT a year a superposed power installation has been saving the Weirton Steel Co. an average of 15,000 tons of coal per month—180,000 tons per year. Two 400,000-lb.-per-hr. boilers supply steam at 850 lb. pressure and 820 F to a new 10,000-kw. turbine which exhausts at 225 lb. to the old turbine plant.

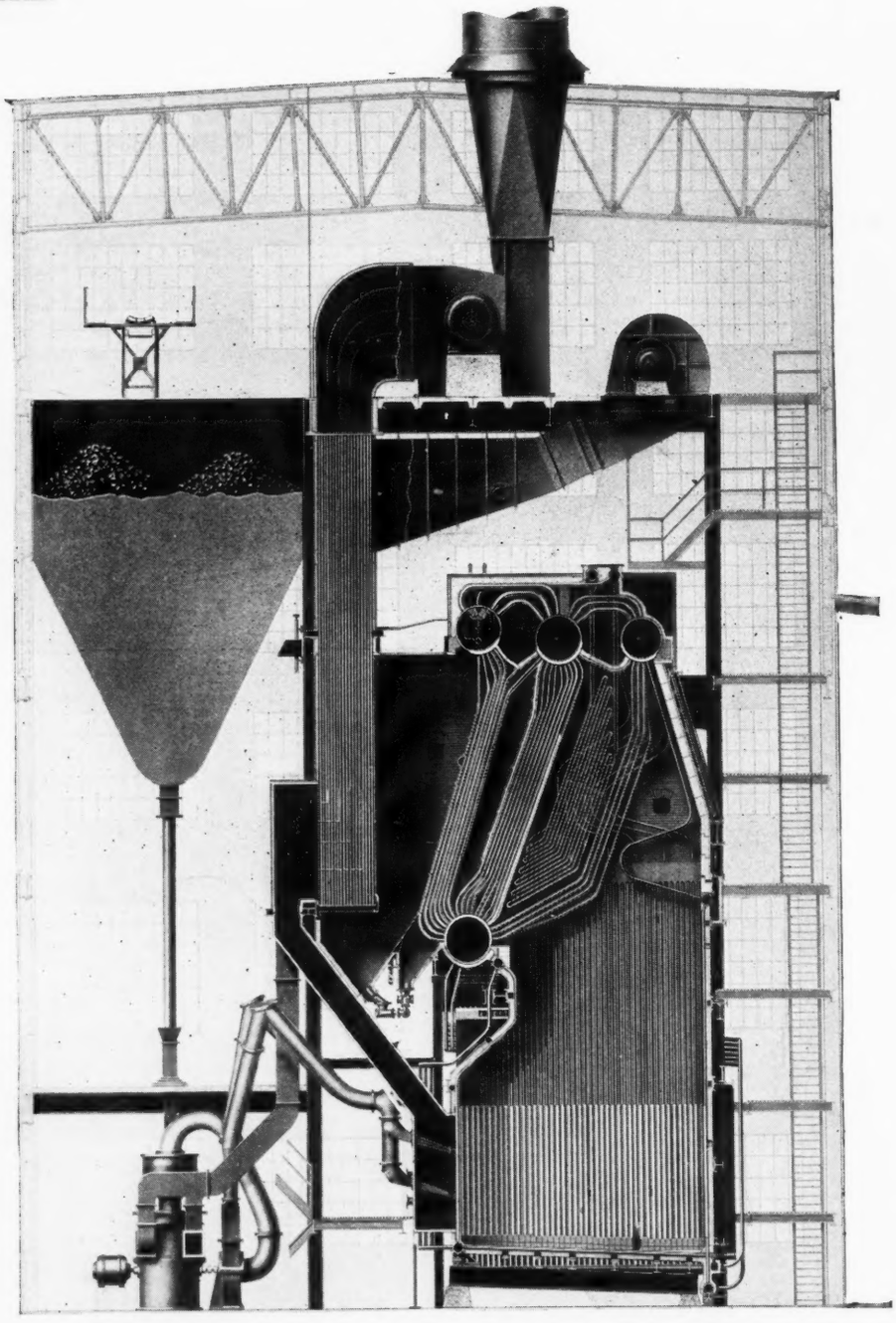
Before describing this new plant, with its spectacular performance, I must give the background of Weirton's recent power history. The power problem, always important in steel plants, has become doubly so with the introduction of modern continuous rolling mills, particularly wide hot-strip and cold-strip tandem mills. It takes about 35,000 hp. to roll 2,000 to 3,000 tons of steel per day on a completely electrically-driven mill.

### Two Low-Pressure Plants

Early in 1934 power demands began to crowd capacity at Weirton. An increasing proportion of finished light-gage steel in the output gave warning of a further heavy increase in load. In particular, "Weirite," a newly-developed cold-rolled tin plate of high ductility (displacing the old pack hot rolled product) was a big factor in the greater demand for power.

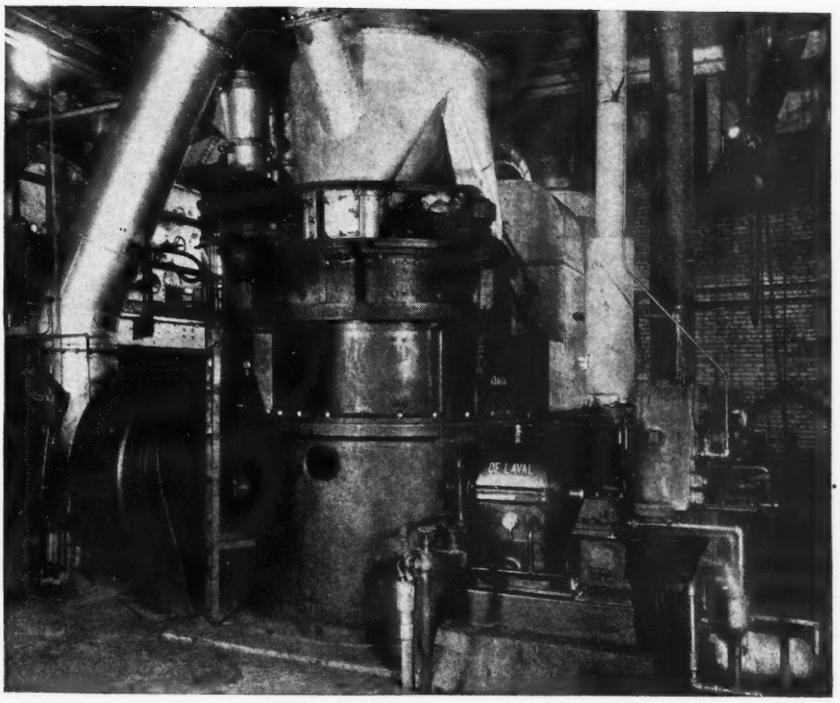
The three major facts considered, aside from load growth in planning expansion, were: (1) Weirton generated its entire load and had to continue to do so, for there was no outside power supply, (2) power was supplied by two low-pressure stations, and (3) available water supply for boilers was 100% treated make-up, as all condensers were barometric.

In the larger station (215 lb. and 100-deg. superheat) five 7,500-kw. turbines were available. Operating at high load factor (about 80% average), this plant made the bulk of the mill's power requirements. After 10 to 15 years' service, it still held close to original operating and thermal efficiencies. Its 35 boilers were coal-fired, some with pulverizers, some with underfed stokers. Much of the steam, however, was generated with by-product fuels and waste heat (blast-furnace gas, coke braise and open-hearth waste heat). Any enlargement would have to absorb these. This boiler plant was being operated to the limit to carry the load. Equipment was in good physical shape, but with no capacity safety margin.



**(Boiler cross section) Two 400,000-lb.-per-hr. units generate steam at 825 lb. and 820 F. Pulverized coal, fired in a water-cooled slag-bottom furnace, is reinforced by coke-oven gas**

In the smaller power plant were two 3,000-kw., 150-lb., turbo-generators with three 1,000-kw. mixed- and low-pressure turbo-generators. Electrical lines were tied to the larger plants, but there was no steam connection. Prime movers were in good condition and worth preserving as standby in any power extension. However, the boiler plant, which also supplied much steam for process and mechanical drive, was about 25 years old and had reached the stage where expensive boiler rebuilding was necessary.



Turbine-driven pulverizer

We decided to continue generating the entire power supply of the steel plant, because of the large investment already made in generating equipment and the existence of a trained operating personnel. It was logical to add capacity, as the addition would have reduced operating costs, whereas purchased power would have increased cost of generating power in the existing plant. We decided, also, to install enough steam capacity at the 225-lb. station to permit dismantling the older 160-lb. boiler plant, and to steam-tie the 225-lb. plant to the 150-lb. prime movers.

Right at the start we had to choose between the existing 225-lb. and some higher steam pressure. Extension of the 225-lb. plant would have required a large increase in steam generating capacity and have added little to the overall efficiency, so superposed turbines were studied for both 800-lb. and 1,200-lb. throttle pressure. The 800-lb. set-up required approximately 25% more steam than the 1,200-lb., with installation cost about the same.

The 800-lb. set-up was chosen for two reasons: (1) the greater amount of steam required for power generation (as compared with 1,200 lb.) was a distinct advantage in making available enough 225-lb. exhaust to completely displace the 160-lb. boiler plant, and (2) the decision to use treated water for the high-pressure boilers made 800-lb. more advisable.

### Advantages of Superposing

The superposed plant showed many advantages over extension of the 225-lb. system. First, addition of a single 10,000-kw. turbine exhausting at 215 lb. and 540 F would reduce the plant steam rate 30%. Such a top, as has been pointed out by others, really generates by-product power at a cost of about one-third pound of coal per kw-hr. Future addition of a second high-pressure generator would still further lower overall plant steam rate. A second point was that installation of a back-pressure turbine required no additional condensing capacity or condensing-water supply.

Finally, the extended plant had to be able to handle large power swings and be so arranged that new steam-generating equipment would take most of these swings, leaving low-pressure boilers free to operate at low load on by-product fuel and waste heat. The superposed turbine solved this problem because every kilowatt it generated exhausted enough steam to produce 2 kw. in the low-pressure condensing turbine. This meant that a jump of 3,000 kw. on the topping turbine would exhaust enough excess steam to produce an additional 6,000 kw. on the old generator, giving a total increase of 9,000 kw. without adding to the load of the low-pressure boilers. This has worked out as predicted and has been a stabilizing governor on both the electric and steam plant.

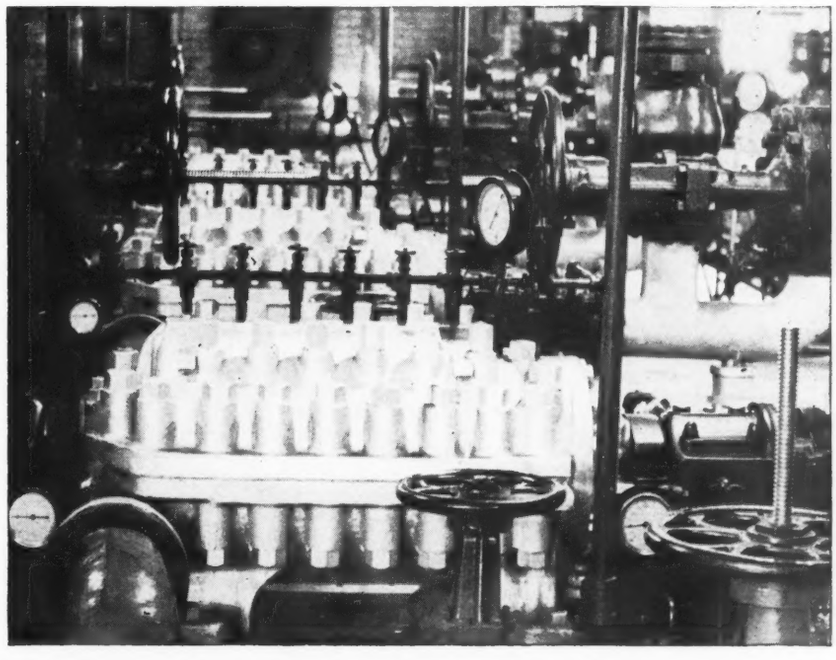
### Two 400,000-lb.-per-hr. Boilers

Selection of the Stirling-type boiler was largely a result of type of feedwater available. Design was based on liberal steam-drum volume (for good separation of steam and water) and on moderate heat release rates, 25,000 B.t.u. per cu.ft. normal, 31,000 maximum. Steam drum was made extra large and provided with a steam washer using feedwater. Thus, clean dry steam was doubly assured. To allow for 100% makeup, steam surfaces were proportioned for moderate rates of evaporation.

The boilers have each a normal rating of 315,000 lb. per hr., and a peak of 400,000 lb., at 825 lb. and 820 F. Either can operate the turbo-generator at 10,000 kw. and carry a peak of 12,500 kw. While the second turbine was held for later installation, the two boilers were installed at the start, because steel-plant operations required that one boiler be always available.

The generator is a 12,500-kva. unit

Boiler-feed pumps



(10,000 kw. at 0.8 power factor). Since normal power factor is close to unity, and turbine capacity is ample, a full 12,500 kw. can ordinarily be generated. Steam conditions are 800 lb. and 800 F.

Because of its ability to care for large and rapid load swings, pulverized coal with slag-tap furnace was specified. Boilers were also equipped with coke-oven gas burners to use excess gas on week-ends and holidays when mill operations are low. Each boiler is fired by two pulverizers, one steam-driven, one motor-driven. Forced- and induced-draft fans are steam-driven. These steam-driven auxiliaries make this high-pressure plant independent of power interruptions.

### 100% Treated Makeup

Feedwater was chemically treated in two steps: first, hot process lime-soda; second, meta phosphate. Leaving the hot-process tank, feedwater was filtered and then pumped to a deaerating heater of 600,000 lb. per hr. capacity at 0.00 oxygen content. Heated there from 210 to 218 F, it passed to a 300,000-gal. storage tank below, and then by gravity to boiler-feed pumps (3 steam-driven, 800-g.p.m. each, at 1,000 lb.). After being heated to 230 F in a blowdown heat exchanger, the water entered the boiler-drum steam washer. The secondary phosphate treatment was applied at the suction of feed pumps.

Continuous blowdown keeps the solid concentration in the boiler water under 2,500 p.p.m. This system includes:

(1) A flash tank generating flash steam at 215 lb., (2) the high-pressure heat exchanger, and (3) a raw-water heat exchanger reducing blowdown temperature to within 10 deg. of the incoming water supply. For good operating conditions it has been found necessary to operate with 10% continuous blowdown.

Some preliminary water analyses obtained before installation of new equipment are given in Table I.

**Table I—Water Analyses, P.P.M.**

| | Parts per million Sample 1 | Sample 2 | Sample 3 |
|---|---|---|---|
| Silica $SiO_2$ | 6.3 | 6.0 | 4.3 |
| Equiv. calcium bicarbonate, Ca $(HCO_3)_2$ | 12 | ... | ... |
| " calcium carbonate, $CaCO_3$ | ... | 20 | 10 |
| " calcium sulphate, $CaSO_4$ | 160 | ... | ... |
| " sodium hydroxide, NaOH | ... | 8 | 2 |
| " sodium carbonate, $Na_2CO_3$ | ... | 32 | 42 |
| " sodium sulphate, $Na_2SO_4$ | 36 | 194 | 192 |
| " sodium chloride, NaCl | 40 | 40 | 37 |
| Oil | 10 | 7 | 8 |
| Total soluble solids | 250 | 304 | 295 |
| Suspended matter | 8 | 11 | 2 |
| Total solids | 258 | 315 | 297 |
| Total alkalinity as equiv. sodium carbonate | ... | 42 | 45 |
| pH value | 6.9 | 9.3 | 9.3 |

Sample 1 — Ohio River at plant intake. Sample 2 — Hot-process treated water before filters. Sample 3 — Hot process treated water after filters.

Sample 3 shows the type of water available before adding the phosphate secondary treatment. Our experience so far indicates that 250 lb. of phosphate are used per day if raw water has 7½-grain hardness and primary treated 0.5 grain. With raw water hardness at 3½ grains, primary treatment is carried to between 0.6 and 0.7 grains and 180 lb. of phosphate are used daily. Normally, 15 lb. of meta phosphate are used per million pounds of water. Concentration of boiler water is held between 900 and 1,150 p.p.m. of sulphate, or between 1,800 and 2,250 p.p.m. of total solids. Phosphate concentration is held between 50 and 80 p.p.m. of $PO_4$.

Conductivity tests on these boilers showed that saturated steam leaves the steam drum with 0.15 to 0.51 p.p.m. of solids, and that equivalent moisture varies between 0.0094 and 0.0239%, the higher reading being obtained with a boiler-water concentration of approximately 2,150 p.p.m., and the lower reading with a concentration of 1,500 p.p.m.

### Combustion Control

Combustion control for the two boilers was specified to maintain efficient combustion conditions and a reasonably constant steam pressure at varying loads. Prime requirements were simplicity, accessibility, reliability, flexibility. Average total load on both boilers is 600,000 lb. per hr., and load swings of 150,000 lb. may come at any time.

A master sender is mounted at the rear of the master panel and generates a pneumatic impulse in accordance with load demand, as indicated by departure of header pressure from standard. This impulse passes to two compensating boiler relays, which provide means for dividing total load between the boilers as desired, or for placing either unit under manual control for "base load" operation.

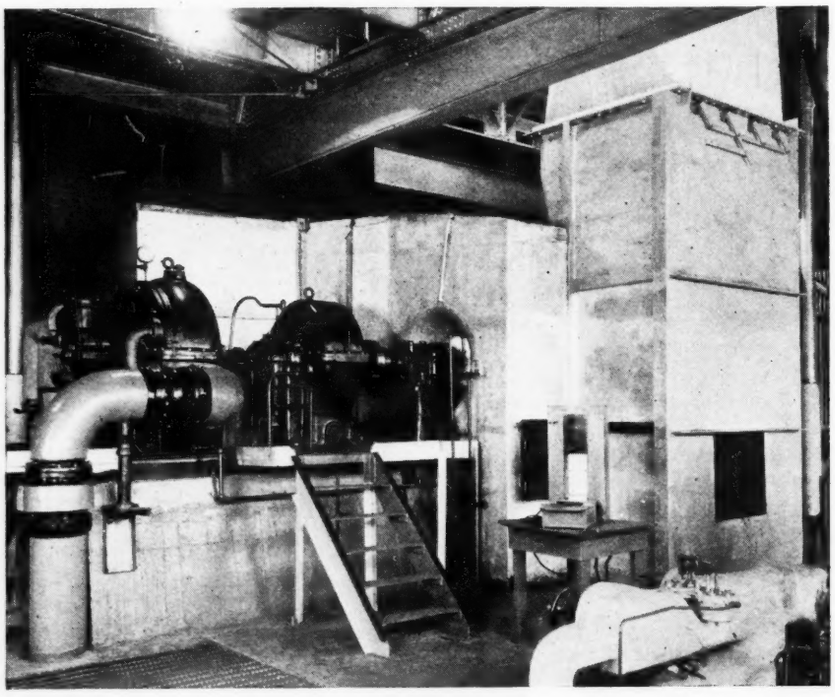
The impulse from each boiler relay passes to each of three ratio-type relays, two for fuel control of individual mills and one for air-flow control.

The relay controlling each mill is calibrated to modify the boiler-relay impulse with field observations of individual mill operating characteristics. Impulses from coal-feed relays are utilized to control rate of coal feed to the mills and the rate of primary air-flow by a dual receiving regulator and standard receiving regulator, respectively.

The dual receiving regulator operating the fuel-feeder control includes a feature applied on this job for the first time. One bellows of the dual receiver is actuated by impulses proportional to boiler load as described above. The other is actuated by impulses which indicate amount of coal in the mill. In this way, fuel feed is automatically adjusted to maintain a predetermined quantity of coal in the mill. Quantity is automatically graduated over the operating range so that at maximum rating the quantity of coal in the mill is increased with rating.

This device, known as the "Mill Charge Corrector," is a unit regulator which adjusts amount of coal in the mill to the steam-chest pressure in the case of the turbine-driven mill,

**Induced-draft fan and drive**



Master panel of combustion control

and to the current supplied to the motor in the case of the electrically-driven mill. By correcting rate of fuel feed, this device holds the steam-chest pressure and current input of these drives within predetermined limits and thus automatically regulates amount of coal. Manual adjustment of fuel relays is calibrated for one- or two-burner operation. Either mill may be placed under manual control if desired.

The air-flow relay is similarly calibrated so that the rate of air-flow may be hand adjusted for any number of burners in service. The impulse from the air-flow relay is used to operate the metering element of the forced-draft air-supply system. Metered forced-draft quantities are controlled by a diaphragm regulator, which in turn operates a bellows-powered steam-regulating valve to control forced-draft-fan turbine speed. This control is so accurate that no damper control is needed.

### Coke-Oven Gas Control

Coke-oven gas may be supplied to the main burner, but a fixed minimum pressure must be maintained in the gas main. To insure use of available excess gas, a diaphragm regulator, connected to the main, is adjusted for minimum pressure. A receiving regulator operates a butterfly "spill-over" in accordance with the impulse from the diaphragm regulator, permitting excess gas to go to the burner. Heat input represented by this fuel is allowed for by the coal control system. The receiving regulator is connected with the interlock systems of both boilers, to close the gas valve if forced-draft or induced-draft fans fail on either unit in service.

When coke-oven gas is being burned, rate of gas flow is similarly measured by the same forced-draft regulator, and rate of forced-draft delivery is automatically adjusted to the proper value.

### Furnace-Draft Control

Furnace draft is kept constant by a diaphragm regulator, which actuates a bellows-operated steam-regulating valve controlling the speed of the induced-draft-fan turbine. This control is of the type used to control the forced-draft fan unit.

Safety check relays are installed to respond to failure of either forced- or induced-draft delivery. Failure of forced-draft trips out the mills, while failure of induced draft interrupts supply of both the fuel and forced draft.

Relays for both boiler units are grouped on the main panel board, together with manual controls for fan valves. Safety check relays and forced-draft regulators are also grouped on the main operating floor. This makes all control units accessible and has contributed much to good operation.

Table II gives the analysis of the coal fired on these boilers:

**Table II—Coal Analysis**

| | |
|---|---|
| **Proximate analysis** | |
| Moisture | 5.0 |
| Volatile matter | 39.7 |
| Fixed carbon | 49.0 |
| Ash | 11.3 |
| Sulphur | 3.2 |
| B.t.u. per lb. dry | 13,250 |
| B.t.u. per lb. M. & A. free | 14,950 |
| Grindability | 58 |
| **Ultimate analysis** | |
| Carbon | 73.1 |
| Hydrogen | 4.9 |
| Nitrogen (calculated) | 1.5 |
| Sulphur | 3.2 |
| Ash | 11.3 |
| Oxygen | 6.0 |
| Calculated B.t.u. (Dulong) | 13,280 |
| **Fuse point of ash** | |
| Initial deformation | 2,050 F |
| Softening temp. | 2,110 F |
| Fluid temperature | 2,420 F |

A year's operating experience with this plant has fully justified the 800-lb. "top." Most notable result has been the already mentioned saving of about 1,500 tons of coal per month.

**Principal Equipment in Power Plant**

Boiler, superheater, air heater and water walls—boiler Stirling type; boiler heating surface 20,487 sq. ft., pressure 850 lb., total temperature 820 F, maximum steam rating 400,000 lb.; water walls Bailey type 4,277 sq. ft. heating surface; furnace vol. 17,280 cu. ft.; max. heat liberation 31,000 B.t.u. per cu. ft.; air heater 49,500 sq. ft. of heating surface. Babcock & Wilcox Co.
Breechings.....Babcock & Wilcox Co.
Water columns
Diamond Power Specialty Corp.
Feedwater regulators.....Swartwout Co.
Soot blowers
Diamond Power Specialty Corp.
Non-return valves.Edward Valve & Mfg. Co.
Blow-off valves.....Babcock & Wilcox Co.
Ash-sluicing system.....Hydro-Ash Corp.
Automatic combustion control.Hagan Corp.
Meters and instruments...Bailey Meter Co.
$CO_2$ recorder.....Leeds & Northrup Co.
Indicating pressure gages
Consolidated Ashcroft Hancock Co.
Coal pulverizers—bowl type
Combustion Enginering Co.
Coal burners.....Babcock & Wilcox Co.
Gas burners.....Babcock & Wilcox Co.
Induced-draft fans....B. F. Sturtevant Co.
Forced-draft fans.....Buffalo Forge Co.
Boiler-feed pump.....Ingersoll-Rand
Service and auxiliary pumps
Dayton Dowd Co.
Coal handling .....Gifford Wood Co.
Boiler-feed turbine drives
Moore team Turbine Corp.
Forced- and induced-draft fan turbines and gears.....Terry team Turbine Co.
Pulverizer turbines and gears
De Laval Steam Turbine Co.
Deaerating heater.....Elliott Co.
Chemical feeding equipment.Cochrane Corp.
Hall system of phosphate feeding
Hagan Corp.
Reducing valve.....Mercon Regulator Co.
Desuperheater.....Elliott Co.
Safety valve
Consolidated Ashcroft Hancock Co.
Power-control valves
Consolidated Ashcroft Hancock Co.
Continuous blowdown control valves
Consolidated Ashcroft Hancock Co.
Globe, gate and check valves
Chapman Valve Mfg. Co.
Forged steel valves, 2 in. and under
Edward Valve Mfg. Co.
Continuous blowdown heat exchanger and flash tank.....Foster Wheeler Corp.
Piping.....Grinnell Co.
Pipe covering.....Johns-Manville
Automatic service water strainer
H. A. Brassert & Co.
Turbine generator—one back pressure type—steam conditions throttle 800 lb., 800 F, capacity 10,000 kw. at 0.80 PF, exhaust conditions 215 lb. 540 F
General Electric Co.
Switch gear.....General Electric Co.

# Diesels + Steam = Power

***Two 225-hp. and a 300-hp. diesels, a 225-hp. turbine and three 250-lb., 2,000-sq. ft. boilers comprise new steam-diesel plant at New York University***


**By Andrew I. Peterson**

*Asst. Prof. Engrg. Economics*
*College of Engrg.*
*and Resident Engr. for Bliss Bldg.*
*and plant, New York University*

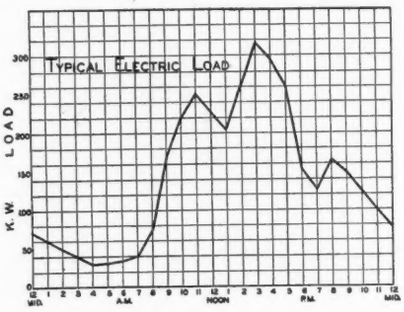

NEW YORK UNIVERSITY has grown impressively in recent years, particularly at its University Heights center. Steam and electricity requirements likewise increased, presenting unique and interesting problems, including many difficult loads in the extensive laboratories of the College of Engineering.

Distribution of these services has always been a significant factor, since the property and buildings extend over fifty acres. Steam lines operated well at moderate pressures and distribution of engine exhausts from a central plant was therefore practical. In view of the extensive underlying rock, patented conduit was largely used in place of tunnels. In earlier days, electricity was needed for lighting only and was supplied at 110 volts by the then-conventional d.c. generators, no doubt with considerable economy. With increase in demand, however, a duplicate distribution system gradually grew up, with 2-phase a.c. at 220 volts purchased from the local public utility. Plant lighting breakdown service likewise was purchased, the proportion gradually increasing because of limited private capacity and a desire for alternating current.

In 1928 the original boiler plant suddenly failed from fire-seam embrittlement. The experimental steam plant of the College of Engineering was quickly offered for temporary use. Its equipment was not designed for service conditions, but with addition of underfeed stokers it carried the load. Temporary use continued, but new buildings soon threatened the reliability of the two hard-driven boiler units. Also, limited combustion volume made double-screened, semi-bituminous coal necessary at a premium price, since smokeless performance was important, thus adding to operating costs already swollen by increasing maintenance.

It was realized early in 1931 that careful study had to be given new capacity and lower costs. A statistical analysis of the economic and engineering characteristics gave interesting results, but most significant was the remarkably reliable correlation between steam and electricity demands compared in ratio to the expected engine water-rates per kw. This was of such order as to make a new steam-electric plant with exhaust heating extremely promising. Long-term normal trends indicated an average annual growth of 3% in maximum demand and 5% in consumption. Provision was made, however, for approximately 100% increase in the initial firm capacity of both electrical and steam equipment.

Existing steam load consisted of an annual instantaneous peak of 20,000 lb. per hr. with a 240-day seasonal consumption of 30,000,000 lb., or a load factor of 26%. The electrical annual ½-hr. demand was about 400 kw., consisting principally of 240 kw. in lighting and 50 kw. in constant base-load power, with the balance from the coincident portions

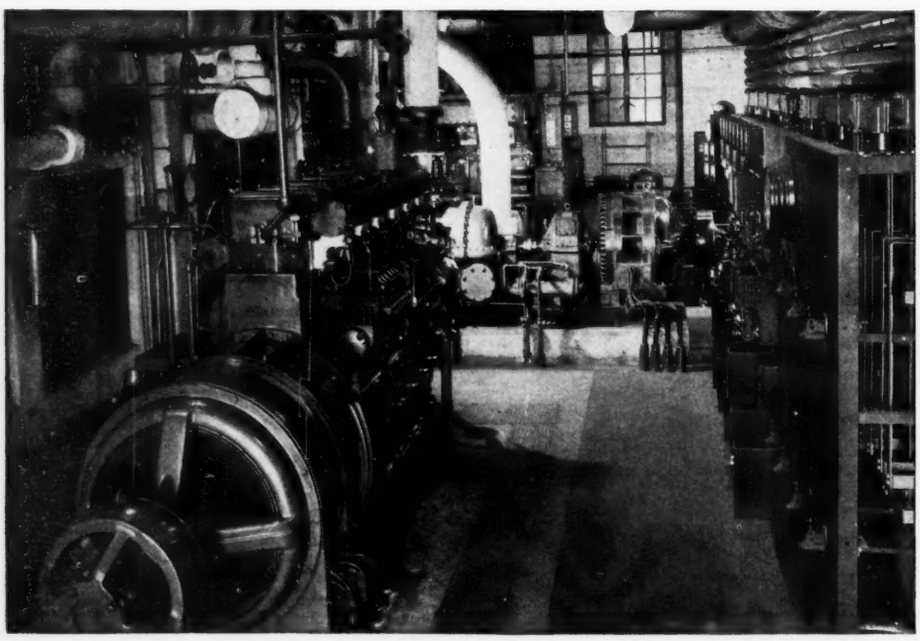



of infrequent large-motor starting peaks. Annual consumption was about 600,000 kw.-hr., giving a load factor of approximately 17%. With the addition of the new Bliss Building, in the lower stories of which the power plant was housed, these loads increased.

Total capacity installed for the present, including reserve as explained below, is 700 kw. in 3-phase, 208-volt, a.c. generators, and 1200 developed hp. in steam boilers, or 6,000 sq. ft. of main heating tube surface at 200% rating. As optimum economy of steam-driven generators is realizable with non-condensing operation for heating, expensive condensing equipment is not feasible for summer use in a small plant.

In the economic analysis, careful judgment was exercised. The steam plant was necessary as a result of inadequacy, in addition to the appreciable saving in out-of-pocket expense. Electric-generating features were considered separately to remove any doubt from claimed economies. Construction and operating costs were estimated on an incremental basis, and all proper expenses were included. Anticipated savings were of sufficient magnitude to allow extra margin for such contingencies as variations in estimate, lowering of purchase rates, and the like. As another factor, the College of Engineering desired a modern steam and diesel electric-generating plant under actual operation.

The economic selection of fuel was

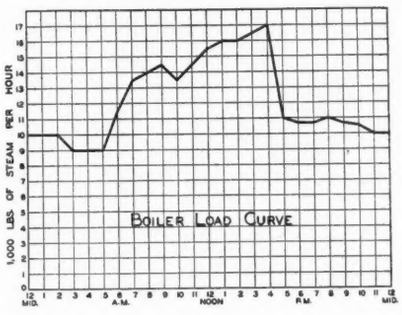


**The engine room showing the 300-hp. diesel, the 225-hp. turbine and the two 225-hp. diesels in order, with the switchboard at right**

another matter for extended study. From operating characteristics of the available equipment and careful estimates of fixed charges, operating costs and average efficiencies, typical break-even cost curves were drawn for the range of output expected during plant life. There were three considerations: anthracite on chain-grate stokers; semi-bituminous on underfeed stokers; and No. 6 fuel oil. For this particular installation, a break-even point between semi-bituminous coal and oil proved slightly below the existing output, with increasing divergence in favor of the coal with load growth.

The boiler design pressure selected is 250 lb. gage, with 100-F superheat at 150% rating, the principal governing factors being pressure for all possible uses in the engineering laboratories and sufficient superheat to the turbo-generator to permit dry heating steam at the furthermost building.

Boilers chosen are Combustion Engineering, box-header, straight water-tube types, with an oversize, fusion-welded, single, cross-drum of $\frac{5}{8}$-in.




plate, 119½ x 48 in. Three of the eventual four boilers are installed. Each has 103 tubes, 3½ in. dia., No. 9 gage, 18 ft. long. Elesco superheaters provide 308 sq. ft. of surface, installed between the main tube bank and the circulation tubes above, and are sprung from externally-connected headers. Baffles are arranged vertically for three passes, with breeching uptake at the top of the settings. Setting height is established at 13 ft. to provide ample combustion volume for experiments with coals up to 33% volatile. Five Diamond soot blowers are on each boiler, with automatic valves and cast-steel revolving heads.

Combustion Engrg. underfeed stokers have single retorts, and side dumps, each with 41.52 effective or 44.00 sq. ft. of projected grate area. Furnaces are 6 ft. 11 in. wide by 6 ft. 4 in. long. Dump trays and retort rams are steam driven. Forced-draft fan equipment consists of Wing turbine-fan integral blowers, at the rear of each boiler, delivering 7,000 cu. ft. of 100-F. air per min. at 4 in. of static windbox pressure.

Specifications require 75.5% combined efficiency of each boiler unit, smokeless combustion with bituminous coals up to 33% volatile matter, and a guaranteed capacity of 225% of rating for two hours.

Settings are constructed of No. 1 and No. 2 firebrick only, and furnace walls lined with air-cooled Bernitz carborundum block from a point 5 in. below the grate line to 20 in. above.

Early considerations favored a minimum of fan operation to keep maintenance costs low. Steam turbo-blowers in the settings permitted throttling combustion control with a reasonable minimum investment. Allowing only 3 in. maximum pressure in the wind box and conservative overfire draft, the Custodis radial-brick chimney is designed for 200% rating of the totally completed plant. It is 6½ ft. in diameter and 140 ft. high over the grates. Regulation is obtained with a Hagan automatic combustion control, consisting of a 5-in. master regulator with mechanical connections to the stoker-regulating valves and the draft-blower regulating valves. Each boiler is also equipped with regulators attached to dampers behind the stoker.

Breeching is of $\frac{3}{16}$-in. steel plate, reinforced, arranged in the conventional 4-boiler manifold with a single connection to the chimney. It is covered with 1½-in., 85% magnesia blocks over a ½-in. air space, and the whole covered with 1 in. of hard-finish asbestos in two coats. The exterior section from building to chimney is additionally covered with a weatherproof asphaltic compound.

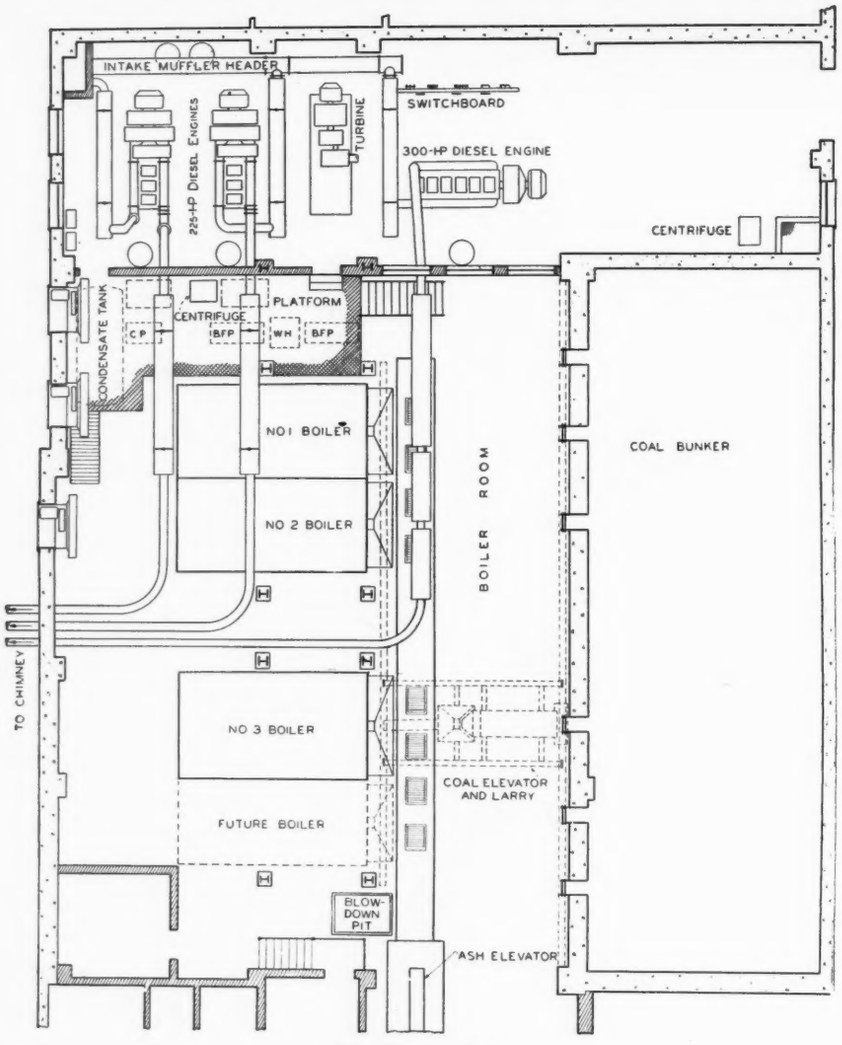
The steep hillside and the natural grade of the coal bunker truckway at one end of the building permits gravity flow to the boiler-room floor. A Jeffrey bucket-type enclosed elevator lifts coal from the downspouts to an overhead 1-ton weigh larry on a traveling crane. Remote-controlled driving motors, magnetic brake, and photo-electric cell make the transport, weighing and filling operation convenient and semi-automatic for one fireman.

Because of rock, a conventional ash-pit hopper and conveyor underneath the boilers is not feasible. A drag-link conveyor is installed flush with the floor in front of the boilers, and ashes are hoed directly into it. A vertical bucket elevator, electrically interlocked with the drag, lifts ashes to the overhead steel storage hopper at the lower truck-entrance door.

Heating condensate had always been returned to the plant, with little loss, by the usual electric pump receivers in each building, and the makeup of oxygen-bearing city water could be kept to a minimum. It was considered sufficient for the present to install a Cochrane deaerating feedwater heater, raising the returned condensate from 140 F to 220 F. Consideration of acidity-control was left for later.

The plant-returns tank could not be mounted high enough for gravity feed to the heater, and, in turn, give sufficient head for feedwater pumps. A Goulds centrifugal circulating pump, driven by a Terry steam turbine, transfers water from tank to heater. The latter is mounted on a mezzanine platform grating, near the engine room and high enough to furnish at least 12 ft. head on boiler pumps below. This permits the engineer easily to inspect the heater from the engine-room door, and the fireman to supervise his pumps at the end of the firing aisle. The circulating pump is not installed in duplicate, but emergency service is provided for in a bypass directly from returns tank to boiler pumps. Duplicate boiler pumps are Goulds, single-stage, double-suction units, driven by Terry "Type Z" steam turbines, and individually large enough for the entire installed capa-

**Three of the eventual four 2,000-sq.ft. boilers are installed**




**General floor plan**

city of 36,000 lb. per hr. Each is equipped with a spring-loaded, diaphragm-operated regulator or governor in the steam supply, maintaining excess pressure in the pump discharge at a predetermined level. At the boilers, water levels are maintained by individual thermostatic regulators, although hand control is facilitated by pipe loops and bypass valves convenient to the firing aisle.

Main steam piping is arranged for three pressures: approximately 240 lb. working pressure to the turbo-generator; 150 lb. intermediate pressure to the laboratories; and 15 lb. to the campus exhaust heating system. All heating steam is expected to be supplied by turbine exhausts, except at heating peaks or unusually low electric loads. Deficiencies are to be made up by 2-stage pressure reduction through pilot-type reducing valves and an Elliott desuperheater. The latter reduces temperatures sufficiently in the intermediate and low-pressure stages to protect auxiliaries such as stoker-ram cylinders and the older underground distribution systems on the campus. Water from feedwater pumps is used for desuperheater sprays, the latter being vaporized and distributed as steam and returned with the condensates, without surplus or loss in the cycle. Plant auxiliaries are supplied from the intermediate stage.

A 1-piece welded high-pressure steam header is connected to the header in the engine room by expansion U bends and controlling valves over the mezzanine platform. Another loop supplies the 2-stage pressure reduction, so located on both sides of the engine room partition and observation windows, that the pilots, valves and desuperheater can be supervised by the engineer in the engine room. Intermediate, 150-lb. steam is distributed to plant auxiliaries by a secondary header over the boilers, and to two of the three building load centers, principally for Chemical and Mechanical Engineering laboratories. Low-pressure steam at 15 lb. is controlled by a large header running the length of the engine room, receiving exhausts from the main turbo-generator, the stoker, pump and blower auxiliaries, and the surplus not used by the feedwater heater, distributing therefrom to the buildings on the campus. Connections of auxiliaries and feedwater heater to the 15-lb. header are so made that they can be segregated for separate operation at different pressures when desired. Two back-pressure relief lines are therefore provided with separate, adjustable, spring-loaded, back-pressure valves, discharging to a spiral-riveted, wrought-iron vent to the roof. Boiler and superheater safety-valves are connected by slip joints to standard piping to the building roof.

All high-pressure and intermediate-pressure pipe is extra-heavy, meeting A.S.T.M. specifications for high-temperature service. High-pressure lines have Van Stone, square-lap, raised-face flanges with alloy-steel bolting and corrugated ring-gaskets of soft Swedish steel. High-pressure valves and flanges are of cast steel, the former having non-corrosive, hard-metal disk-rings and seats. Intermediate, or 150-lb. pressure, valves and fittings are semi-steel. For pressures below 125 lb., the piping was specified to be "standard," and fittings to be cast iron.

Each boiler is equipped with a conventional combination combustion panel, containing an integrating and recording flowmeter, a boiler horsepower indicator and a 3-element Ellison draft gage. In the center aisle, between boilers, is a duplex electric $C0_2$ and flue-gas temperature recorder operated alternately for each boiler in a regular cycle of observations. Transfer is accomplished by means of multi-point switches. Recording thermometers with 2-pen elements permit observation of inlet-outlet conditions at the feedwater heater, and checking desuperheater performance by steam temperatures of high- and low-pressure headers. For general testing, miscellaneous thermometer wells, test plugs and gages are installed throughout the plant. All instruments were installed by Brown Instrument Co.

For control of desuperheater temperatures, a Brown "Air-O-Line" unit, consisting of an automatically-compensated, air-operated controller and recorder, and an accurate valve-positioner, controls flow of cooling spray water to the desuperheater. Excellent results have been obtaind thus far.

There were, in addition to the general characteristics of load affecting unit size, several large motors whose starting would have created serious voltage disturbances before voltage regulators could act. One was a 310-hp. synchronous motor-generator set, another was a 75-hp. induction motor-generator, a third was a 75-hp. automatic sub-station unit. For ex-

ample, sub-transient starting inrush of the first-named unit was calculated at approximately 425 kva., even with a low starting-compensator tap. In addition were architectural limitations in the academic surroundings, need for exact frequency control for general and laboratory timekeeping, and necessity for complete elimination of vibration, noise and odor because of the classrooms directly above the plant as well as the many buildings which surrounded this power generating unit.

#### Base-Load Units

After extensive investigation, the selected base-load units were: two heavy-duty, 225-hp., solid-injection, 360-r.p.m., 4-cycle diesel engines; and one 225-hp., 5,124-r.p.m., non-condensing turbine. All are directly coupled to a.c. generators, rated at 150 kw., 187 kva., 3-phase, 220 volts, 40-C max. rise, except that the turbine drive is through a 5124/1200-r.p.m. reduction gear. Exciters are directly driven. There was also selected a specially designed generator, rated 312 kva., 250 kw., 720 r.p.m., 40-C rise, but with the frame of a 438-kva. unit, directly driven by a 6-cyl., 300-hp., locomotive-type diesel. The extra-size generator frame permits low flux densities and more stable voltage regulation, when separately starting the 310-hp. motor in the Aeronautics Building.

Diesel equipment, with all piping and auxiliaries, was manufactured and installed by American Locomotive Co. and the turbo-generator unit was manufactured by General Electric Co. Extensive engineering investigations and responsibilities were defined in the contracts of these companies in order to guarantee a very high order of parallel operation of these dissimilar units, particularly in view of the use of 3-cyl. machines for the base-load diesels. A coefficient of speed fluctuation of 1/250 was specified, and incorporated by the manufacturer in the engine designs. Woodward isochronous governors are used on the diesels, and the GE Lynn-type governor on the turbine.

All units have massive reinforced-concrete foundations, mounted on special Korfund "Cork Isolator." Surrounding trenches and cover plates provide space for auxiliary piping, give more effective isolation than usual cork or sand, and guarantee a dry condition of the underlying cork.

Undesirable pulsations are completely removed by Maxim mufflers and wave traps, and gas is discharged to the plant chimney through long individual engine lines as shown. In case chimney temperatures should drop below the dewpoint during summer months when boilers are not operating, the chimney is lined with an acid-proof mortar. Engine air intakes are likewise treated with mufflers, and in addition are supplied from a masonry pulsation chamber and flue, leading to air filters on the roof.

Engine-jacket water and lubricating oil are cooled by Young radiators, installed in the three large window openings of the boiler room as indicated. Fans are driven by wound-rotor motors, controlled by rheostats and pilot lights in the engine room. In this manner, architectural prohibitions on cooling towers and ponds are satisfied, and by blowing cooling air outward, boiler- and engine-room ventilation is secured without the possibility of radiator freezing.

#### Switchboard

The dead-front General Electric switchboard is installed with seven panels, four for the generators, one for totalizing instruments and two for distribution switches. Engine and turbine governor motors are controlled from the board for convenient paralleling. Voltage regulators have cross-compensation equipment for controlling equalization of current and power factor between machines.

The high-speed diesel-generator, assigned to panel No. 4, is connected directly to the feeder for the 310-hp. motor in the Aeronautics Building by a 1,200-amp. disconnect behind the board, between the generator and the circuit breaker to the bus. Indicating-lamp pushbuttons furnish the only means of starting the motor, and are electrically interlocked with the Breaker to prevent paralleling with the main line until the starting sequence of automatic motor controls has been completed. If emergency trips were operated by the testing crews at the tunnel, starting inrush then could not be imposed upon the main bus and the generator had to be first taken from the line. Desirability of paralleling the high-speed unit with the main-load units is seen in the large idle capacity available most of the time. Although designed for a 100-m.p.h. wind speed, the tunnel is usually operated at 60 m.p.h. A falling-off of needed power as the cube of the air speed leaves most of the generator's capacity idle unless proper provision is made. Such operation is expected for only 3 to 4 hr. per day. At other times the unit is to be used for peak-load service or emergency standby. A high-speed diesel was therefore a sound selection for such light-duty cycles.

#### Future Plans

All operating data cannot be released until after an appreciable period of breaking-in for the best operating balance of steam and electric equipment. Ample space has been made for future expansion of both steam and electric capacity.

Compactness of the plant permits an operating force of the same size as would have been used for a steam plant alone, with the possible exception of a part-time extra engineer-fireman supervising the boiler room during the day watch. Aside from this, the plant staff consists of one engineer and one fireman per watch.

As indicative of preliminary results and operation, a summary report for March is shown. Steam and electricity loads are illustrated by the typical curves shown. Previously, the heating curve had the usual high morning peak for heating-up with a rapid falling off after late morning. Since fireproof buildings possess a high thermal "storage" capacity, it was possible to readjust the operating cycle of heating hours and shift the peak to the afternoon. This permits similarity of hourly variations of electricity generation, exhausts and heating requirements, and helps to increase the use-factor of the turbo-generator, with consequent economy.

#### Exceptional Promise

Exceptional promise has been shown by the plant, and the real savings are expected to exceed the original estimates. Many individuals contributed to its success. Among these were principally Dean Emeritus Collins P. Bliss, whose vision brought life to both the plant and the classroom building above, and Thorndike Saville, dean of the College of Engineering and chairman of the Building Committee. Much credit should also be given to Col. Oliver F. Allen, whose kind consulting advice was so gainfully utilized. Harold Torgersen of the Department of Electrical Engineering checked electrical design and supervised initial operation.

**ENGINE OPERATION — MARCH, 1937**

| | Hrs. Run | Kw.Hr. Gen. | Gal. Oil | Kw.Hr./Gal. | Kw.Hr./Hr. | Load % |
|---|---|---|---|---|---|---|
| 150-kw. diesel | 135 | 11,300 | 997 | 11.57 | 83.8 | 55.0 |
| 150-kw. diesel | 177 | 14,600 | 1,246 | 11.72 | 82.5 | 54.0 |
| 150-kw. turbo-gen | 662 | 51,000 | ..... | ..... | 77.0 | 41.0 |
| 250-kw. diesel | 77 | 7,800 | 728 | 10.70 | 101.2 | 50.0 |
| Total | 1,051 | 84,700 | 2,971 | 11.34* | 80.6 | .... |

* Three diesels only.

# Oil for the Dedusting of Coal

***An investigation of the use of mineral oils for dedusting coal and their influence in controlling spontaneous combustion***

**By H. A. Ambrose and H. J. R. Gaspari**
*Research & Development Div., Gulf Oil Corp.*

ALTHOUGH spontaneous heating and spontaneous combustion of coal have been studied for almost a hundred years, little attention has been given to methods of prevention excepting strictly physical treatment of coal during storage. Treatments with chemical solutions have been suggested, but these are more successful in allaying dust than in preventing spontaneous combustion. A typical example, spraying with a solution of calcium chloride, has practically no effect on spontaneous combustion, although it does reduce dusting.

Proposed physical methods for reducing the tendency to spontaneous heating include: (1) storage in the substantial absence of air, (2) packing coal to reduce porosity of free air space to a minimum, (3) stacking with provision of ventilation sufficient to cool the interior of the pile, (4) grading coal to eliminate fines, and (5) submerging in water. Although each has merit, none of these methods is widely practiced.

This is not the place for an extended discussion of the mechanism by which coal heats spontaneously. An enormous number of papers have been published on this subject; those up to 1928 are accurately summarized by Davis and Reynolds.[1] Subsequent papers cover rates of air or oxygen absorption, ignition temperatures and the chemical mechanism of coal oxidation.

Several independent investigators have assigned specific causes for spontaneous combustion, but are not wholly in agreement, doubtless because of the complex chemical structure of coal and differences in coals from different ent localities. Regardless of the presence of oxidation accelerators in coal, and regardless of the influence of moisture, sulphur, pyrites, etc., it is known that coal oxidizes and that oxidation may start at atmospheric temperatures. And this, of course, results in the development of heat which causes a temperature rise. An additional purely physical action, which may also take place—absorption of gas on the surfaces of the coal particles—is well known in the case of charcoal. Nitrogen may be absorbed by coal without any chemical action; the mere physical absorption results in the development of heat.

In general, without assigning the specific causes of oxidation, other than that coal is a chemically reactive material, it may be stated that development of heat results from absorption of gases, reaction of oxygen with coal to form solid compounds, and reaction of oxygen with coal to form volatile products such as CO, $CO_2$ and water. At temperatures below 50 C (122 F), oxygen reacts with coal to form solid products, thus the coal gains in weight. Below this temperature, very little $CO_2$ is formed. At elevated temperatures, either solid compounds decompose or are further oxidized with evolution of CO, $CO_2$ and water. Since coal is a poor heat conductor, heat of reaction is not readily dissipated and the temperatures may rise until ignition temperature is reached. Ignition temperature varies with the grade of coal and with the state of subdivision, as does the tendency to spontaneous combustion.

As stated, heating may be due to a combination of physical and chemical reactions, the latter of which predominate. It is well known that the physical condition of coal has a large influence upon its rate of heating. The rate of reaction between a gaseous and solid substance is directly proportional to the surface area of the solid exposed to the gas. Considering a cube of coal of any volume, its surface area is equal to $6L^2$, where $L$ is the linear dimension of the cube. The surface area of a 1-in. cube of coal is 6 sq.in. If the 1-in. cube is reduced to 20 mesh (U.S. standard), the aggregate surface area amounts to approximately $6L^2 \div L^3$ or $\frac{6}{L}$, where $L$ is the linear dimension of the maximum-size cube which will pass a 20-mesh screen. For 20-mesh coal, then, aggregate surface area approximates 192 sq. in. Surface area of a cube of coal ground to pass a 200-mesh screen is approximately 2,000 sq. in., 333 times the surface area of the 1-in. cube. Thus the relative surface exposed by finely ground coal is very large, accounting for its ease of oxidation. Dust explosions may be accounted for by the large surface area exposed, resulting both in reduced ignition temperature and increased rate of oxidation by flame.

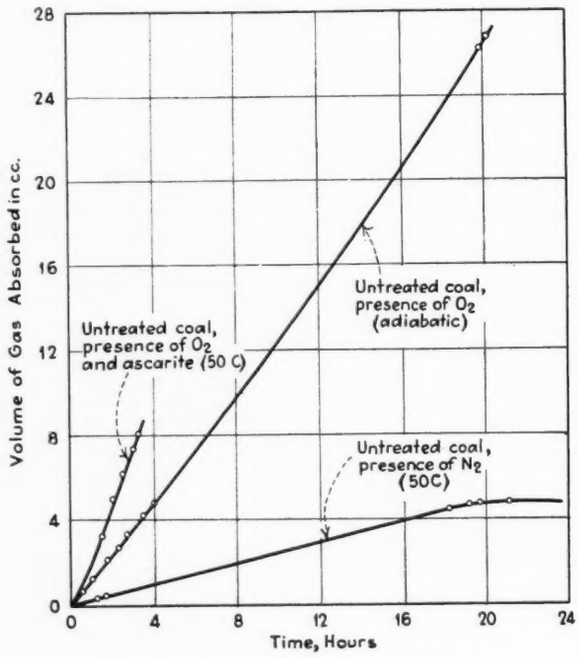



Fig. 1—Apparent absorption of gas by coal

Spraying coal with oil for dedusting is a relatively modern development. Oil spraying improves coal in several ways: (1) when properly applied, it eliminates from 70% to 90% of the objectionable dust from fines, (2) decreases spontaneous combustion or tendency to fire in piles, (3) minimizes absorption of moisture, (4) minimizes freezing during transit or in storage, (5) improves movement and prevents arching in bunkers, stokers, etc., (6) lessens degradation resulting from handling, and (7) renders coal non-corrosive to metals.

The effects of oil on spon-

[1] *J. B. Davis and D. B. Reynolds, Bur. Mines Technical Paper 409 (1928).*

taneous combustion have not been publicized, largely because of the absence of definite experimental evidence in corroboration of favorable data obtained from actual service tests. Experimental methods for determining the reduction in heating tendencies are relatively simple, however, and are of particular value in selecting proper oils for application to coal.

Protecting solid fuel against spontaneous combustion by treatment with petroleum oil dates back at least as far as 1906[2] when Sterne proposed a process of treating lignite with oil or crude petroleum to prevent disintegration. Records show that coal was sprayed with oil commercially more than 10 years ago.

The mechanism by which oil prevents heating is not chemical but physical. When sprayed on coal, a sufficiently non-viscous oil is drawn into and clogs the capillary pores, retarding the rate at which oxygen is drawn into the interior. Building up a heavy liquid layer on the coal surface is not necessary. It has been shown that increasing the ratio of oil to coal above ½ to 2 gal. per ton for average sizes is not useful because additional increments of oil are of little effect in retarding oxidation. The greatest effect is obtained by the first ½ to 1 gal. As shown by Galloway[3], rate of oxygen absorption is decreased by hygroscopic moisture in the pores (a clogging effect) but not by surface moisture.

### Oil Volatility

Coal-spray oils should be relatively non-volatile in order to minimize loss by vaporization during the spraying operation. It is less desirable to use a light distillate with a high rate of volatility than to use reasonably close cut distillate relatively low in volatile fractions. Once coal has been sprayed, oil volatility is not important, since motion of air over the oil surface is restricted enough under storage conditions to prevent excessive loss from evaporation. Bulk of evaporation occurs on the outside of the pile, where heating is not a problem; evaporation is negligible in the interior which is protected from air currents. Furthermore, the more effective fraction of oil is absorbed in the pores of the coal and is not vaporized by air currents.

Commonly, coal-spray oils should have a viscosity of approximately 100 S.U.V. at 100 F, but oils having a viscosity of 200 S.U.V. may be used. Lower viscosity oils are more desirable because of greater ease in handling, pumping and spraying, and they tend to penetrate the coal pores more readily than oils of higher viscosity.

Since oxidation of coal results in development of heat, it is of interest to consider both volume of oxygen absorbed and rise in temperature due to heat of reaction. Davis and Byrne[4] studied the oxidation characteristics of various coals with an adiabatic calorimeter, following both oxygen absorption and temperature rise. The early part of our investigation was carried out in a similar manner, following the progress of oxidation in a bath so constructed that the temperature of the bath increased with that of the coal, no heat of reaction being lost to the outside surroundings. This bath is described by Weinrich and Gaspari.[5]

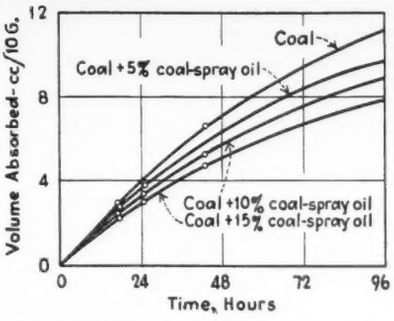



Fig. 2—Absorption of oxygen at 50 C by coal (200 mesh)

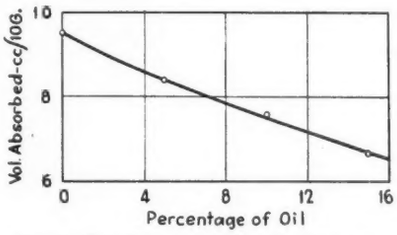



Fig. 3—Relative rate of absorption vs. amount of oil (200-mesh coal)

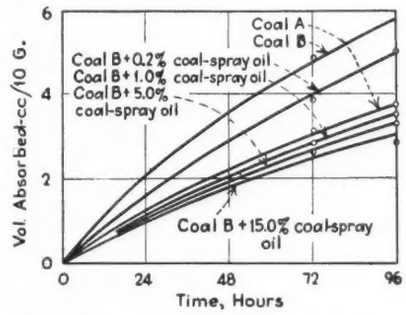



Fig. 4—Absorption of air at 50 C by coal (8–10 mesh)

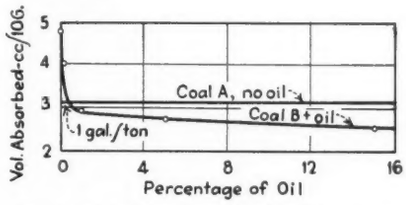



Fig. 5—Relative rate of absorption vs. amount of oil (8- to 10-mesh coal)

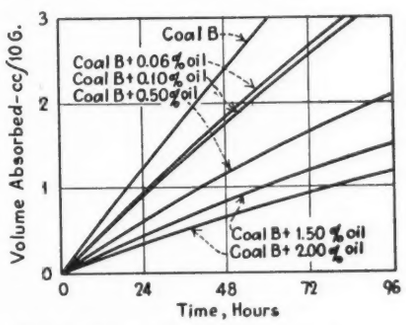



Fig. 6—Absorption of air at 50 C by coal (8 mesh to ½ in.)

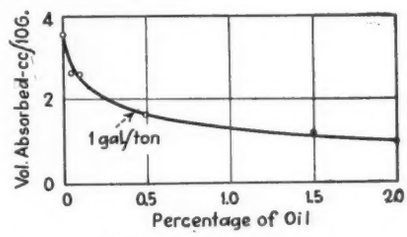



Fig. 7—Relative rate of absorption vs. amount of oil (8-mesh to ½-in. coal)

**Gas Absorption and Heat of Reaction**—Curve 1, Fig. 1, shows the rate of apparent oxygen absorption by a sample of coal under adiabatic conditions. The curve is concave upwards, since the increasing temperature of the coal increases the rate of reaction. A temperature-time curve is similar in form to Curve 1, the rise in temperature being about proportional to time.

Curve 2 shows the apparent absorption of nitrogen by a freshly ground coal sample which had been deaerated by blowing with nitrogen before exposure to an atmosphere of nitrogen in the reaction chamber. Apparently absorption is complete at about 20 hrs.

Curve 3 shows the apparent rate of oxygen absorption in the presence of an absorbent (ascarite) for $CO_2$ and water vapor.

**Coal Sampling**—The adiabatic method of oxidizing coal, while furnishing complete accurate information on single samples, is too cumbersome and slow a method, and not readily adaptable to simultaneous study of a large number of samples. It is difficult to duplicate results unless several samples of coal ground from a single batch and well mixed to obtain similar specimens are observed concurrently. For an accurate comparative study of the effect of various proportions of oil on coal, each sample should be similar in both physical and chemical properties to every other, and prepared under the same conditions. Chemical composition and reactivity vary greatly from one piece of coal to another. All comparative tests should be performed simultaneously on samples taken from a batch of coal ground and graded to the desired mesh, and then well mixed.

**Simple Method of Comparing Oxidation Characteristics**—In order to obtain rapid

[2] *U. S. Pat. 838,281, Dec. 11, 1906, Louis Sterne.*

[3] *William Galloway, Colliery Guardian, 128, 1000 (1924).*

[4] *J. D. Davis and J. F. Byrne, J. Am. Ceramic Soc. 7, 809 (1924).*

[5] *Whitney Weinrich and Hannibal Gaspari, Ind. Eng. Chem. 8, 307 (1936).*

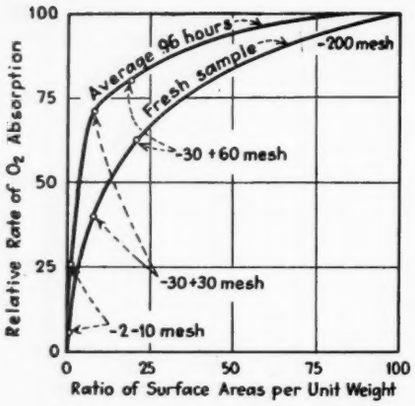



**Fig. 8—Relative rates of oxygen absorption for smaller mesh coals**

comparative results, a method was devised in which coal samples were thermostated and apparent rate of air or oxygen absorption was measured by decrease in pressure on a mercury manometer directly connected to each reaction vessel. A similar apparatus was used by Bunte and Brückner.[6]

In brief, the method was: a lump of coal was ground and sieved to required mesh. 50-gram samples were placed in 250-ml. Erlenmeyer flasks sealed with a rubber stopper through which was fitted a mercury manometer tube for measuring drop in pressure, and a straight tube for pressure equalization. When gas in each flask had come to bath temperature, the straight tube was sealed and the reaction proceeded. Manometer pressures were corrected for barometric changes and calculated to apparent volumes absorbed.

**Experimental Results**—Figs. 2 through 7 show the experimental results obtained for coals of different sizes coated with various amounts of coal-spray oil. Fig. 2 shows the apparent volume of oxygen absorbed by 200-mesh coal as a function of time and of the proportion of oil. Fig. 3 shows the volume of oxygen absorbed in 72 hours as a function of percentage of oil by weight of coal. It is important to note that rate of oxidation of 200-mesh coal is only moderately affected by oil even in porportions as high as 15% by weight of coal.

Figs. 4 and 5 illustrate the relative rates of reaction of coal with air, comparing Coal *A*, known to be relatively free from heating in storage, with Coal *B*, which heats excessively in storage. It is shown that approximately one gallon of coal-spray oil per ton is required to reduce the oxidizing tendency of the Coal *B* to that of the Coal *A*. The reduction in relative rate of absorption for 8- to 10-mesh coal (1 gal. of oil per ton) is approximately 35% as against 48% for 8-mesh to ½-in. coal, as shown in Figs. 6 and 7.

Although it is well known from practical service tests that coal-spray oil is of considerable effect in reducing dusting and heating, it has been found desirable to obtain laboratory data on the effectiveness of various oils. An extended series of investigations has shown that heating, the forerunner of spontaneous combustion, is definitely due to air oxidation. Results of this investigation corroborate the fact that the heating tendency is increased by the presence of fines and that it is a desirable practice to eliminate fines from storage piles. Excellent evidence in support of this view is given by Winmill,[7] who shows that relative rates of oxygen absorption are extremely high for the smaller mesh coals, as shown in Fig. 8. Ignition temperatures are high for coarser coals, decreasing rapidly with fineness until a size of about 100-mesh is reached, as shown in Fig. 9.

Effect of coal-spray oil in reducing spontaneous heating is quite evident on coals as fine as 8- to 10-mesh, but

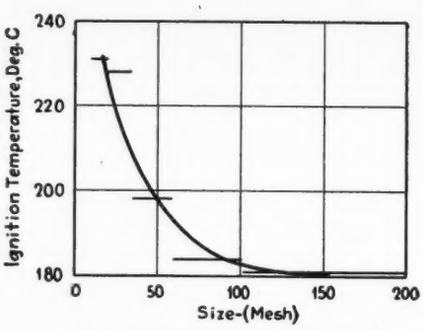



**Fig. 9—Ignition temperatures vs. mesh size of coal**

is of little advantage on dust because of the excessive amount of oil required. If one gallon per ton were employed to spray 1-in. cubes of coal, approximately 333 gal. per ton would be required to cover the same surface area on 200-mesh coal, and 32 gal. per ton would be required to cover the same surface area on 20-mesh coal. It is evident that spraying to reduce spontaneous combustion is not economical for finer meshes, although it has the advantage of laying dust. This may be considered its main advantage for coal fines.

[6] *K. Bunte and H. Brückner, Angewandte Chemie 47, 84 (1934).*

[7] *T. F. Winmill, Trans. Inst. Min. Eng. 51, 493 (1916).*

# Smoke Abatement*

Ways and means of obtaining smokeless combustion are well known and have been in practice for many years. Pure air is a matter of intelligently applying and enforcing these principles: correct furnaces, properly controlled and adequate draft, use of proper mechanical stokers, overfire air as required, and proper and careful operation. About 80% of smoke can be eliminated at its source by application of these fundamentals.

The two items reported as most responsible for smoky conditions in our cities are "Lack of Public Consciousness" and "Careless Operation." That smoke can be definitely abated has been proven by two major surveys made in Chicago in 1911 and 1933. While coal consumption doubled in the interval, volume of smoke decreased 5% and its density 51%. Chicago railroads cut smoke 93%, power plants showed a 13% reduction, and industrial furnaces reduced smoke 61%.

Yet the 22-year period shows an increase of commercial heating-plant smoke of 1,640% and an increase in residential smoke of 900%, primarily because these were hand fired. Stokers became available for small commercial heating plants in 1923, but distribution did not reach commercial proportions until 1930. Definite progress is being made and in time smoke from commercial buildings, apartments and residences will be reduced comparable with that of power plants and railroads.

If clean cities and clean air are sincerely desired, rigid qualifications should be required on the training, knowledge and experience of engineers who deal with, design or install any part of fuel-burning systems. The following smoke-prevention program is suggested:

Public sentiment must be aroused.

Newspapers should place air pollution on their "must" list.

A permanent pure-air department should be organized free from political or commercial influences.

Ample funds should be provided for unhampered activities, and a proper ordinance put into effect. Combustion engineers should be licensed.

Designs of plants and furnaces should be made only by licensed combustion engineers.

The department should pass on all designs.

Hand firing of coal should be abolished as rapidly as possible.

The department should be given police jurisdiction firmly backed by the City Council.

Research work should be carried on and contacts maintained with various established research laboratories.

*An abstract of a paper by T. A. Marsh, Central Div. Eng., Iron Fireman Mfg. Co., presented before the Building Officials Conference of America at their Cleveland Convention, June, 1937.

# Exhaust Heats Oil

**An exhaust heater at the Endicott, N. Y., dieselized waterworks heats oil for centrifuging with B.t.u.'s normally wasted**

ENDICOTT Water Co., Endicott, N. Y., has three diesels, two 340-hp. units for water distribution, and a 465-hp. diesel-generator set providing current. Lubricating oil is centrifuged continuously, and formerly was preheated with electrical strip heaters. But current for heating the oil had to be taken from the useful output of the plant, and even if charged at only a cent a kilowatt-hour, rose to an appreciable monthly figure. For example, an 18-kw. heater used in on-and-off service, draws an average of 7 kw. 24 hr. a day, costing $50 in an average month. Also, carbon deposits on heater surfaces in contact with the oil cause frequent burnouts and high maintenance expense.

Goulds engineers therefore developed the exhaust-gas heater of Fig. 1, which is tied into the exhaust line through a Y connection. Without any operating cost, because it reclaims B.t.u.'s normally lost, it heats 150 g.p.h. of oil to the required 175 F. A thermostatic control permits more or less exhaust gas to be passed through the unit to maintain exact temperature, and a simple slide shut-off is inserted in the pipe for closing when the unit is cleaned.

The heater is composed of a head through which exhaust gas enters at the center and leaves in an annular ring, and three cylindrical elements, a casing, a heat exchanger and a baffle (which also acts as the control valve). The heater casing is really a welded cylindrical tank with a flanged top, bolted to the cast head. Inside it is a cast exchanger element with external helically grooved oil passages and internal fins, and inside that is a cylindrical baffle with a top collar, which when dropped closes the gas passage down to the exchanger. The assembly is open in Fig. 3, closed in Fig. 4.

Oil enters at the bottom, Fig. 3, works its way up the helical grooving (the exchanger is a sliding fit within the casing), and out at the top. Exhaust gas passes from the head down through the baffle, then up between baffle and exchanger through the annular valve formed by the baffle collar at the top. The baffle is raised or lowered manually or thermostatically to control valve opening, the amount of gas going through, and thus the heating of the oil.

Carbonization of oil on any part of the heater is avoided by designing for large areas of heat-transfer surface with positive flow over all parts. Exchanger walls are thick for ready conductivity, and have ample sectional area to prevent hot or cold spots. Internal finning is designed to keep exchanger temperature far below gas temperature, within 10 deg. of oil temperature on the outer surface.

The unit may be cleaned easily by dropping the casing, Fig 2, thus exposing the helical oil grooving, and by dropping the exchanger element so that all gas passages can be wire-brushed. Pipe connections are not disturbed. To prevent cooling and condensation in the piping when the baffle is dropped, gas flow is maintained through the head. The unit at Endicott is placed high on the wall over the centrifuge, taking its heat from the exhaust of the 465-hp. engine. Only a small part of the exhaust is needed for this service, leaving the rest for other purposes if desired.

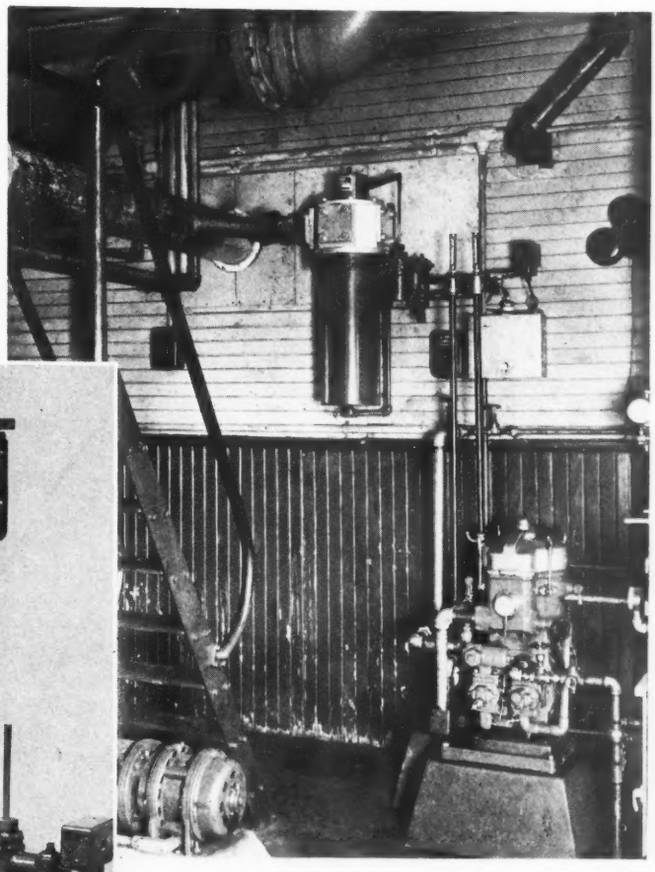


**Fig. 1—The heater hangs on the wall over the Goulds Hydroil centrifuge and beside the exhaust from the 465-hp. engine. The slide valve is for cleaning shut-offs only; an oil-piston thermostatic valve controls temperature**

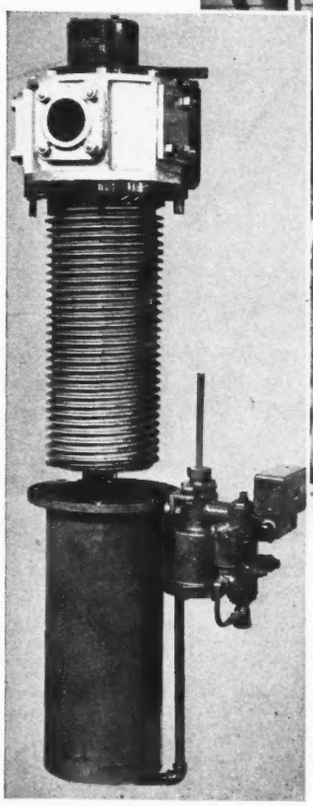


**Fig. 2—The unit open showing the exchanger element**

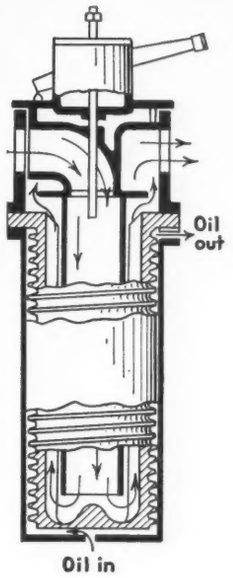



**Fig. 3 (left)—Unit in operation**

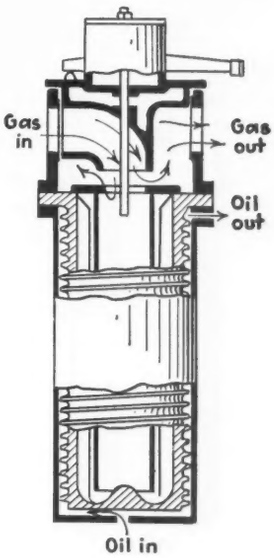



**Fig. 4 (right)—Unit closed**

# Pump Repairs Save Their Cost

***Even 0.015 in. wear in the clearance between casing and impeller of a centrifugal pump may justify renewal of the wearing rings because of the resulting saving in power cost***

**By Frank Kristal**
*Mechanical Engineer, New York City*

CENTRIFUGAL pumps, like all other machines, wear in service, and some of their parts are designed with the intention that they will wear and eventually must be replaced. For example, the rings that form the seal between suction and discharge are even known as "wearing" rings. In spite of this, pumps are frequently installed and more or less forgotten about until something happens. This may be expensive, because the saving in power cost, resulting from keeping the pump in good condition, will pay the cost of repairs many times over.

A major cause of low efficiency in a centrifugal pump is wear of the rings that form the seal between discharge and suction, Fig. 1. When the pump is in good condition, clearance between these rings is small, usually about 0.015 in. Some pumps have renewable wearing rings attached to the impeller and casing. Others have wearing rings in the casing only, as in Fig. 1, the impeller being of harder material so that all wear will be on the casing ring. With either construction, the purpose is to provide a method for easy restoration of the running clearance when wear occurs.

Fig. 2 shows characteristic curves of an 8-in. single-stage, double-suction centrifugal pump which we will assume is rated 2,000 g.p.m. against a total dynamic head of 85 ft. The impeller wearing ring, Fig. 1, is 7.125 in. outside diameter, and the casing wearing ring has an inside diameter of 7.14 in., giving a clearance of 7.14 — 7.125 = 0.015 in. Leakage loss, or flow back into pump suction through this clearance is calculated by the formula $G.P.M. = 3.125\ CAV$, where $G.P.M.$ equals gallons per minute; $C$, coefficient of flow; $A$, clearance area in square inches between runner and casing wearing rings; and $V$, velocity of flow through clearance in feet per second. Coefficient $C$ is usually taken as 0.5 to 0.6; for this problem we will use the value 0.5.

Area of the clearance rings may be found by the formula $A = 0.7854\ (D_1^2 - D_2^2)$, where $A$ is in square inches; $D_1$ outside diameter and $D_2$ inside diameter of the clearance ring in inches. Then, clearance area $A = 0.7854\ (7.14^2 - 7.125^2) = 0.168$ sq. in. Flow velocity in the clearance is $V = \sqrt{2gh}$, where $V$ is the flow velocity in feet per second; $g$ 32.2; and $h$ the head developed by the pump in feet. Then $V = \sqrt{2 \times 32.2 \times 85} =$ 74 ft. per sec. We can now calculate the leakage from the pump discharge into its suction, which is 3.125 x 0.5 x 0.168 x 74 = 19.43 gal. per min.

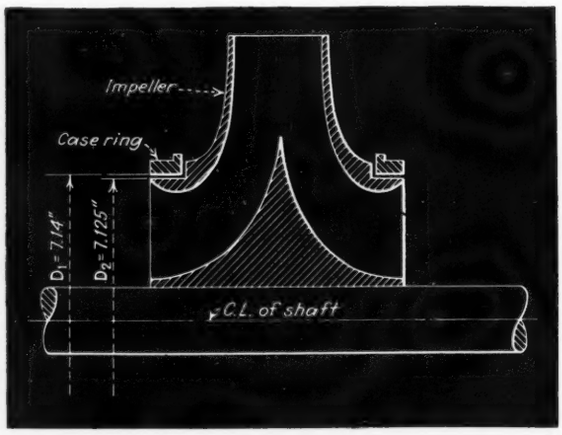



**Fig. 1—Cross-section of centrifugal pump impeller and casing wearing ring**

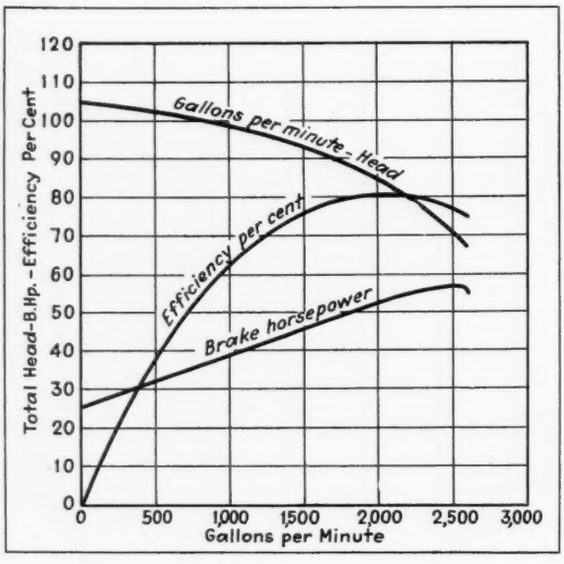
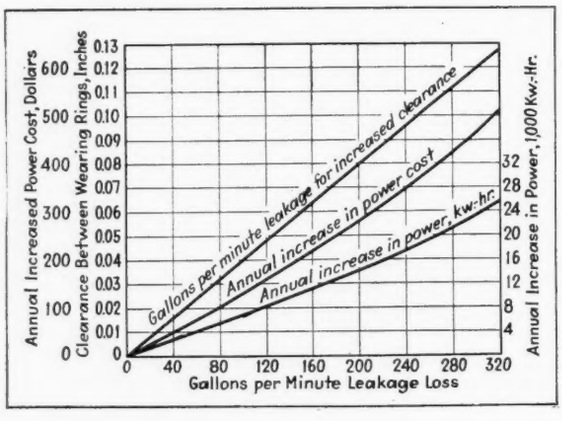



**Fig. 2—Characteristic curves for an 8-in., 85-ft. head, 1750-r.p.m. centrifugal pump**

**Fig. 3—Leakage, power and power cost for increased clearance between the runner and casing of the pump, Fig. 1**



The pump has two clearance rings. Then the total leakage is 19.43 x 2 = 38.86 gal. per min. This is equivalent to (38.86 x 100) ÷ 2,000 = 1.9% of the rated capacity of the pump, 2,000 g.p.m.

This loss has been accounted for in the original design of the pump, and is accepted by the pump engineer as necessary for its proper operation. While attempts have been made to reduce this leakage by closer clearances, there is always danger of metal-to-metal contact when the rings are too close. Some manufacturers obtain a reduction in initial leakage by using labyrinth-type wearing rings. However, regardless of method, initial leakage has been taken into account in calculating the original pump efficiency.

For the pump under consideration, power input to the driving motor is:

$$\text{Hp.} = \frac{G.P.M. \times H}{3{,}960 \times E \times Em}, \text{ where}$$

$H$ equals total dynamic head in feet; $E$ the pump efficiency and $Em$ the motor efficiency. Under the assumed conditions, the pump has an efficiency of 81% as shown by the curve, Fig. 2.

Since power input to the pump is about 53 hp., we may assume a motor efficiency of 90%. Then power input to the motor is $Hp.$ = (2,000 x 85) ÷ (3,960 x 0.81 x 0.90) = 58.9 hp. Of this power, 58.9 x 0.019 = 1.12 hp. or (1.12 x 746) ÷ 1,000 = 0.84 kw. is loss because of leakage through the clearance rings. Assuming that the pump operates 10 hr. per day for 300 days per year, the kilowatt-hours loss will be 0.84 x 10 x 300 = 2,520. At 2c. per kw-hr., this power will cost 2,520 x 0.20 = $50.40.

Loss through the clearance will vary approximately directly in proportion to its size. For example, if clearance rings wear until the space between them is four times the original, or 0.168 x 4 = 0.672 sq. in., leakage would be about four times the original, or 38.64 x 4 = 155.44 g.p.m.

Without considering the effects on pump capacity, the power cost because of leakage is four times that when the pump is new, or 50.40 x 4 = $201.60. Capacity of the pump also will be reduced about 6% because of this leakage so that it will have to operate a proportionally longer time, which will increase the cost of power because of leakage by a like per cent.

A new set of clearance rings for this pump will cost around $25, about one half of the increase in power cost for 0.015-in. wear in the clearance rings. The foregoing is not unusual and many pumps are operating under far worse conditions, when a few dollars invested in new clearance rings would be repaid several times in a year.

In Fig. 3, the increased leakage, power and power cost for increased wear of the clearance between the impeller and casing is shown graphically, for the 8-in. pump under consideration. Data for plotting such curves may be calculated as in the foregoing for any pump, and from them a point can easily be determined at which increased power cost makes it economical to recondition the pump. Then, by checking the clearance between the casing and impeller wearing rings periodically and comparing it with the curves, you can establish an intelligent maintenance program.

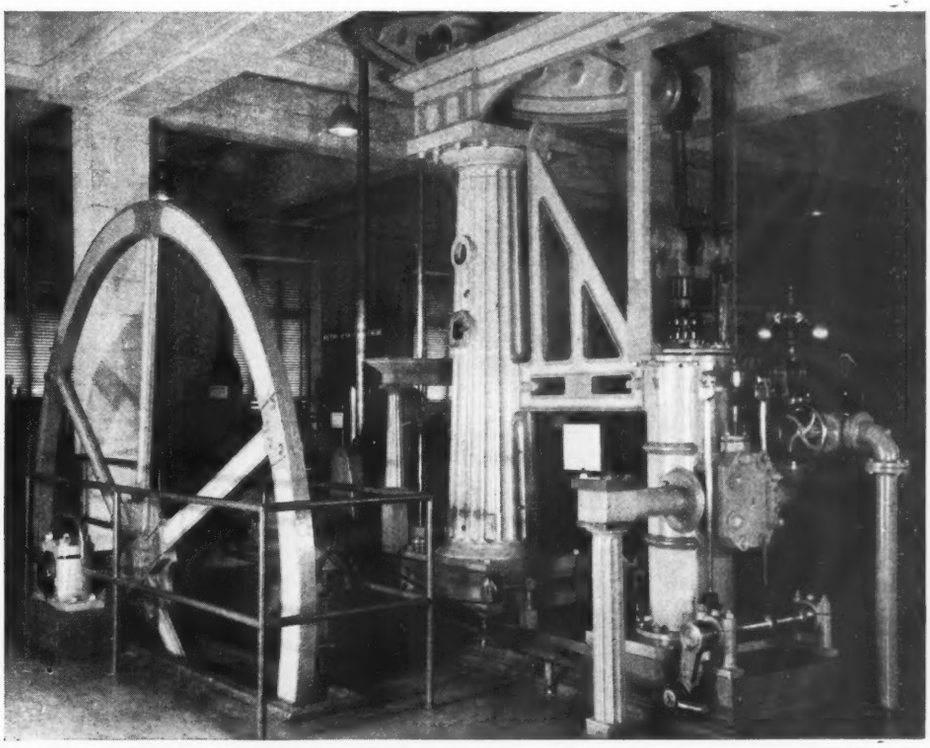
# Retired—After 81 Years

YESTERDAY'S methods, though sometimes crude compared with today's standards, often produced lasting workmanship. In the Prime Movers Division of the Franklin Institute at Philadelphia is an interesting example of sturdy construction—a steam engine built in 1847 by J. T. Sutton & Co., which was in operation for 81 years at the white-lead works of Wetherill & Bros. in Philadelphia.

Originally rated for 40 hp. on 80 lb. steam pressure, the engine at higher speed and 100-lb. pressure developed up to 140 hp. One rather interesting peculiarity is that during the engine's entire life at the Wetherill plant, it ran "under" instead of "over," and very frequently without a governor. Bearings, which are set up with the engine today, are the original brasses; the cylinder during its entire life was rebored only once; and the drive shaft, cut off to get the engine into the space available at the Franklin Institute, is of cast iron.

The engine is a plain slide-valve type with the valve yoke worked from the rocker shaft, which in turn is actuated by an eccentric on the main shaft. The cylinder has a bore of 15 in. and a stroke of 48 in. The beam is carried by a 14-ft. high central column, which once served as an open feedwater heater. Exhaust steam was led from the cylinder through the engine frame to the column, and feedwater flowed by gravity to a plunger pump worked from the beam. The flywheel is about 14 ft. in diameter, and the connecting rod is attached to the center crank by a drag pin.

Wetherill & Brothers naturally grew very fond of the engine, and when it was decided to turn it over to the Franklin Institute, A. P. Wetherill, the only living man who ran the old engine, stationed himself at the controls to stop the engine, with several people in attendance to witness the ceremony. Mr. Wetherill, though, admits chagrin, for he stopped the engine on dead center.



As a guide to the condition of machine windings, insulation resistance should be periodically checked with a megohmmeter

# Clean Equipment Spells Reliability

***A "How-to-do-it" article on cleaning and treating electrical machinery windings to insure reliable operation***

**By Arnold Benson**

*Asst. Prof. Electrical Engineering Dept., Oklahoma Agricultural & Mechanical College*

ELECTRICAL equipment should be kept clean, but here is one case where water isn't the proper fluid to do the job because moisture is one of insulation's worst enemies. A mixture of about 70% cleaner's naptha and 30% carbon tetrachloride will remove oil, grease, dirt and dust from windings very effectively. This mixture is non-inflammable, but care should be taken to ventilate the room as carbon-tetrachloride fumes have slight toxic effects. It may be applied with a brush or with an aspirating nozzle at an air pressure of not more than 60 lb.—a higher pressure may drive dirt into windings instead of blowing it free. And before the fluid is used, blow all dry dirt and dust from the windings and out of ventilating ducts with compressed air.

In plants where dust and dirt are prevalent, blow out the windings and ventilating ducts weekly; where conditions are fairly clean, a monthly blowing is sufficient. Many motor burnouts will be avoided by this practice.

Live steam at high pressures has been suggested for cleaning lint and grease from motors and windings in cotton mills. It should be used with caution, however, as moisture and high temperature may ruin the insulation if steam is directed on one spot for very long. Many multi-motor shops find it good practice to check insulation resistance, which is a handy index to moisture, oil and other deteriorating influences on windings. A megohmmeter is the most common instrument for measuring insulation resistance.

### Minimum Resistance

Minimum allowable value of resistance must be set up for measurement with this instrument and insulation resistance should be measured when the machine is at operating temperature. Minimum value varies considerably, but a value in megohms equal to the machine's rated voltage divided by 1,000, with a minimum of one megohm for all machines rated 100 to 1,000 volts, has been adopted by many engineers. A record of insulation resistance on each machine often saves a burn-out or shutdown; a continuously decreasing insulation resistance foretells insulation deterioration long before it fails. Isolate various parts of the machine, such as armature, field coils and rheostat, from one another when making insulation-resistance measurements. Low insulation resistance is often caused by moisture in the leads to the field rheostat or to a switch located on a moist switchboard panel, or in the insulation of the machine itself.

After motor windings have been cleaned of oil and grease, subsequent treatment will depend upon machine size and facilities available. The best method requires, an oven, of sufficient size to contain the machine, equipped with a temperature control to maintain a constant temperature between 90 and 95 C. Do not exceed 100 C. The machine should be disassembled and the stator placed in this oven for a period of 6 to 10 hr., depending on machine size (the larger machines require the longer time). This brings the machine temperature up to about 90 C, and drives moisture out of the windings. To determine if the machine is dry, check insulation resistance again before dipping.

Sometimes bad spots on the insulation will be disclosed by inspection and can be remedied before the varnish is applied. For example, a path of carbonized grease over the mica V-rings on a commutator will cause low insulation resistance. Dipping in varnish will not usually remedy this condition unless the dirt and foreign matter are removed first.

While the motor is hot, saturate windings with a good baking varnish.

Hang the stator or armature on end over a tub to catch drippings and pour varnish over end connections so that it runs along coils and enters the slots between the coils and the iron. Thin varnish to make it free-flowing. When one end of the winding is well saturated, turn the machine over and treat the other end. Allow the machine to drain 30 min., or until dripping ceases, then place it in the oven and bake for 8 to 12 hr. If time permits, give the windings another treatment and bake. Varnish in the drain vat should be poured back into the can and sealed up for future use.

#### Insulation Resistance

Measure the insulation resistance to determine if baking has progressed for a sufficient length of time. Insulation resistance, after baking, should be 75 to 100 megohms, and a winding in good condition will measure infinity on a megohm meter. The insulation resistance of some windings improves considerably after they cool, because of further drying out of solvents in the varnish.

When the machine is removed from the oven, spray or paint with a coat of black air-drying varnish to give windings a good finish. This will air dry and the machine can then be assembled in about 4 hr., if applied when windings are hot. D.c. armatures should be given a quarter turn every half hour while baking; otherwise varnish may accumulate at a low point and cause unbalance.

#### Drying the Varnish

Where facilities or time are not available to treat windings as previously explained, clean the machine when hot, preferably after a day's run, to insure moisture-free windings. Then after the cleaning fluid has evaporated, spray a coat of air-drying varnish on the windings with an air gun. If a gun is not available, apply varnish with a brush. Be sure that varnish reaches all exposed parts of the coils and entrances to the slots. Allow the varnish to dry for 8 hr. before putting the machine into service and, if possible, apply a second coat 8 hr. after the first and allow it to dry for a similar period.

These treatments seal the coil ends and slots against entrance of moisture and renew plasticity of the insulation. And finally, remember to clean all bearings and slinger rings on the shafts to prevent oil getting out on the windings, as this renders insulation soft and mushy and deteriorates it rapidly.

**Where compressed air or a vacuum system is not available, a portable vacuum cleaner is a handy device**

# Exhaust Lines

### *By E. J. Tangerman*

A "speedometer" for diesels is now being applied by Caterpillar to all 3-, 4- and 6-cyl. engines. Attached to the rear of the fuel-injection-pump housing, it is driven by the pump shaft and registers one number on a dial for each hour of normal-speed operation of the engine, providing a guide for maintenance and lubrication.

*Canada is unusual in the amount of steam it generates from electricity. Out of a total February output of 2,147,635,000 kw.-hr. by central stations, 666,261,000 kw.-hr. was used in electric boilers—a little over a fourth.*

Cuba, preparing the battleship *Cuba* for its trip to the coronation of King George VI, refrigerated food storage rooms with a 1-ton Carrier system. The ship is now on a goodwill tour around the world.

The Italian motorship *Feltre* sunk in the Columbia River recently. Northwestern Electric Co. reached her, though she was near midstream, with an 11-kv. line lashed to piling and leading to a floating substation serving two 200-hp. motor-driven pumps. The line cost $3,500 to put in and take out, and 20,000 kw.-hr. raised the ship.

*If you use flat gage glasses, assign one man to take care of trouble—it will reduce the servicing and insure skilled attention.*

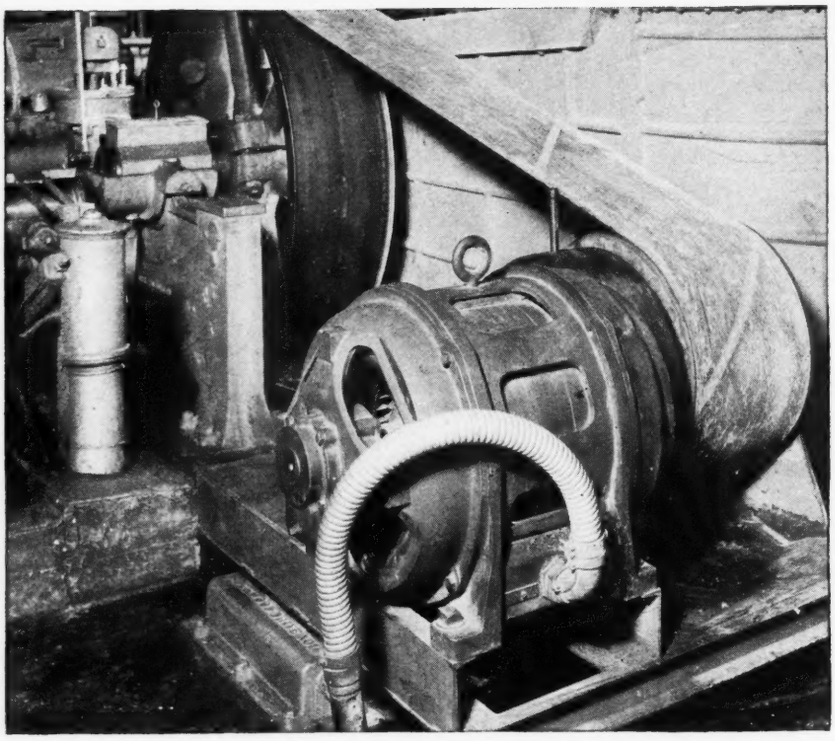
A "gas-tight" metal container really isn't gas-tight, says Dr. Francis J. Norton of GE Research Laboratories. Hydrogen slowly escapes through metal, no matter how thick. In high-pressure boilers, for example, water and iron react to produce iron oxide and hydrogen at above 575 F. The oxide forms a scale, some of the hydrogen escapes through the tubes, some combines with oxygen in the water, but the rest diffuses through the steel. At room temperatures, about a cubic inch of hydrogen will get through thin steel in a hundred thousand years, and as little as 0.1% of sodium chromate will stop that! Apparently it won't worry this generation much.

New York Steam Corp. opened a new feeder main recently to provide 350,000 lb. per hr. to Radio City and other midtown buildings if needed. It is 1175 ft. long, and 18 and 20 in. in diameter.

*Carrier Corp. has been getting a jump on the climate by testing air-conditioning equipment in this country in summer, and down in the jungles of Brazil during January and February, summer down there.*

Hays Corp., Michigan City, Ind., has two interesting arrangements for calibrating instruments. One is a small microscope-like outfit which shows two points which can be made to meet by turning a wheel. Actually there is only one point, the other being its reflection on the surface of the water in which it is submerged. When the points "meet", the single point is really just touching the water surface, and permits measurement of water levels to a thousandth of an inch in pressure calibration. The other instrument is a flat case with 1,000 times the cross-sectional area of the glass tube to which it is connected. Thus pressures applied above the oil in the case are magnified a thousand times in the tube.

The *Hotel New Yorker*, New York City, keeps all its clocks 3 min. fast, but guests are awakened in the morning by correct time. The Pennsylvania, does the same thing, and lobby clocks in the Roosevelt, Governor Clinton and Murray Hill are all fast. The Commodore has fast time in the bar only (to allow for a quick one), the Biltmore and the Waldorf keep their clocks on correct time. The 3-min. advance allows for the "cutting too fine" that hotel guests indulge in, particularly if the hotel is near a station.



A 75-hp., 1,750-r.p.m. gearmotor (with 5-to-1 gear reduction) mounted on a pivoted base and driving a paper-mill beater through a 16-in. belt

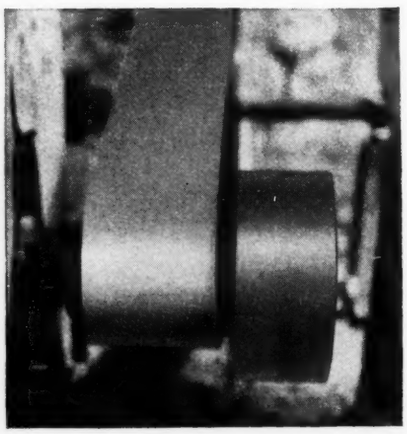
# We Moderns in Power Drives

***Here are suggestions for selecting motors, controllers and mechanical power-transmission equipment to obtain the most economical combination for the application. Particular attention has been given to gearmotors, automatic clutches, belts***

**By F. A. Annett**
*Associate Editor*

APPLICATION of electric power to a machine includes selection of a motor, a controller or starter and a means of connecting the motor to its load. The latter may be a coupling, flat belt, multiple V-belt, chain, gear, clutch, variable-speed transmission, or various combinations of these. To get the most economical combination of motor, starter, and mechanical power transmission, all three must be considered together. This is particularly true at present, because of developments such as gear-motors and automatic clutches that offer new possibilities in power applications. The intention here is not to recommend any piece of equipment over another, but to indicate some of the elements that should be considered in power application.

To illustrate, assume a belt-driven air compressor that requires 46 hp. and has a 42-in. flywheel. A normal-starting-torque, normal-starting-current, 50-hp. squirrel cage motor will drive it. Because of its better power factor and efficiency, a 1,750-r.p.m. motor would be preferable to one of slower speed. First assume that reduced-voltage starting is necessary because of the objectionable starting peak if the motor were connected directly to the line to accelerate the compressor.

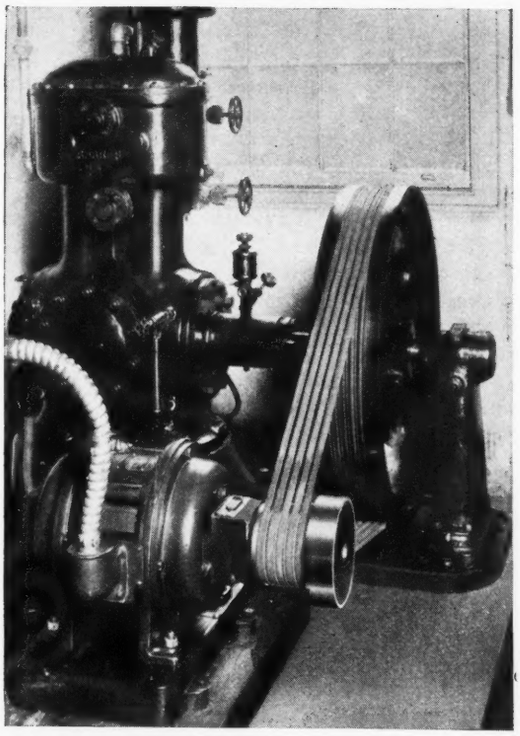


A 10-hp. motor connected to six grinding stones by a flat belt and automatic clutch to limit starting load to 17.5 hp. Starting is done in 35 sec. without any belt slip. Originally a 40-hp. motor was required for starting, but the running load is only 6.5 hp. and the belts slipped excessively during starting before the automatic clutch was installed.

To design a belt for this drive, first determine the peripheral speed of the flywheel, as this is fixed. This wheel is 42 in. in diamter, runs 285 r.p.m. and therefore has a peripheral speed of 3,130 ft. per min. Motor-pulley diameter must then be 6.84 in.—say 7 in. Such a pulley is too small for this drive.

Two things can be done: First a 1,160-r.p.m. or an 885-r.p.m. motor may be selected. The latter will permit a 14-in., rather than a 7-in., pulley to be used. Such a motor without pulley or rails would cost around $550, as compared to $400 for the 1,750-r.p.m. motor.

The full-load power factor of the low-speed motor is about 87%, efficiency 88% and weight around 1,300 lb., compared to 93.5% power factor, 90% efficiency and 800-lb. weight for the high-speed motor. If power factor is a real element in the problem



**Across-the-line-start induction motor connected to refrigerating compresser by multiple V-belt and automatic clutch, the latter to insure easy starting.**

and the compressor is to operate for considerable periods unloaded, the 900-r.p.m. motor may be objectionable, for its half-load power factor is only 72%, compared to 87 for the 1,750-r.p.m. motor. We can get away from part of this difficulty by using a 1,160-r.p.m. motor and a 10-in. pulley, but such a pulley diameter would still be considered too small for good practice. Therefore, it is preferable not to select this motor.

Here one of the comparatively new developments, the gearmotor, may offer the best solution. A 50-hp. gearmotor comprising a 1,750-r.p.m motor and a gear for an output speed of 875 r.p.m. will cost around $600, about $50 more than the 875-r.p.m motor. Whether the slow-speed motor or the gearmotor is used, it should be mounted on a pivot or tension base to maintain correct belt tension automatically. Because the gearmotor weighs considerably less than the slow-speed unit, it can be placed on a lighter base at a saving in cost of about $20, so the difference in cost against the gearmotor will be only about $30. If we go to a gearmotor, it will be satisfactory to select an output speed of about 700 r.p.m. without additional cost for the unit. This speed will permit a 17-in. dia. pulley and make an almost ideal drive. Let us select this for a trial.

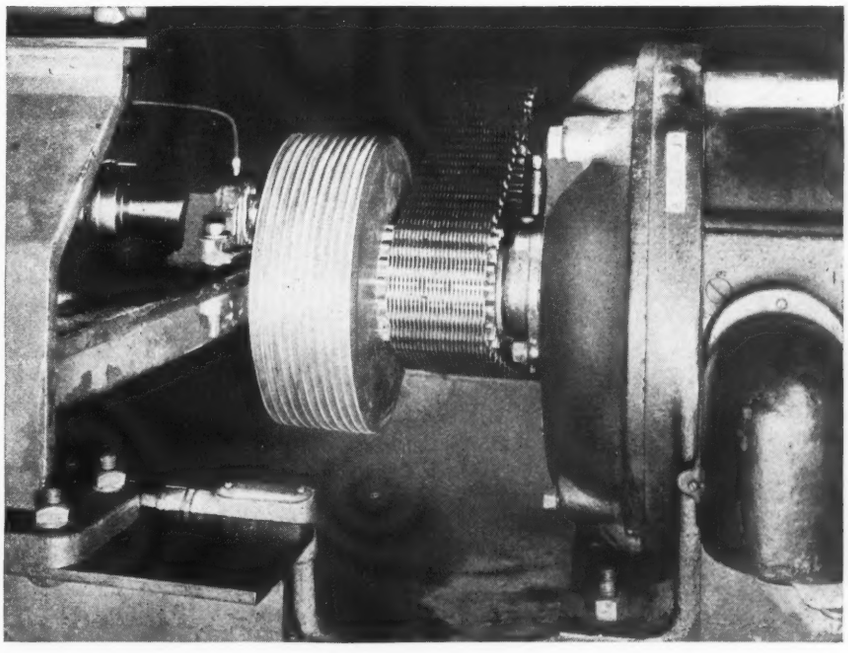
For this type of load, with the motor started on reduced voltage, and the compressor unloaded, a service factor of 1.3 should be used when estimating belt capacity. With 60-in. center distances between pulleys, the small pulley will make a contact of only about 155 deg. with the belt. To compensate for this reduction in belt contact below 180 deg., the required belt capacity should be increased about 10%. Then, the total belt capacity required equals 50 (motor hp.) x 1.3 x 1.1 = 71.5 hp. A good double-medium leather belt at 3,100 ft. per min. will transmit about 7.5 hp. per in. of width. Therefore, for this drive a 9- or a 10-in. double-medium leather belt or its equivalent, a 6-ply rubber belt, will be required. It will be better to select the wider belt. Then if the belt is operated with correct tension for the load, the additional belt capacity will pay big dividends in increased life and reduced maintenance costs. A 17x11-in. pulley should be selected, and will cost $20 for one of a high-grade paper type.

If the 900-r.p.m. motor had been used, it would require a 14-in. pulley, and a 10-in. belt could be used for this drive. The pulley would cost about $15, or $5 less than for the 17-in. pulley, so that the total cost in favor of the 900-r.p.m. motor is 30 + 5 = $35. Balanced against this in favor of the gearmotor are a slightly better belt drive, 300 to 400 lb. less weight, 1 or 2 in. less over-all length, 6 to 7% better power factor at full load and 15% at half load. Where power is purchased and the rates have a power-factor clause, the better power factor of the high-speed motor may reduce the gearmotor power cost from 3 to 5%, depending upon how much of the time the motor operates partly loaded. If it is necessary to use an outboard bearing on the gearmotor, because of the belt load, this will change the cost setup somewhat.

Motors started under no load and on full voltage may be less objectionable on the power system than those started under full or part load at reduced voltage. This brings automatic clutches into the problem. Clutches are now available that permit a motor to come up to nearly full speed before load is applied, after which load is gradually accelerated without shock. These clutches are also designed so that they will slip if the load exceeds a predetermined amount, thus saving machine, motor and connection between from severe overloads. If this connection is a belt, the clutch will prevent load from increasing until the belt slips and burns, entirely possible on certain types of loads.

The cost of starters for motors varies over a wide range depending upon voltage, motor horsepower, full-voltage or reduced-voltage starting, manual or automatic starting, and other factors. A magnetic, across-the-line-starter for the 440-volt, 50-hp.

**Across-the-line-start induction motor connected to winding machine through chain drive and automatic clutch. Clutch designed for frequent starting**



motor under discussion costs around $45 and for reduced-voltage approximately $200, a difference of $155. For this particular make of starter, the 50 hp. size happens to fall in a very favorable position for low price differential. For the 440-volt, 60-hp. size, the across-the-line-starter costs around $110 and the reduced-voltage type $390, or a differential of $280 in favor of across-the-line starting. This would more than pay for an automatic clutch to permit the motor to be started without load.

When belt drives are used with across-the-line starter motors, an automatic clutch will permit the belt to be designed for the running load without regard for starting requirements. This will permit 25 to 50% less belt capacity, as good practice requires that a belt on an across-the-line start motor be good for about double motor capacity.

Where loading of the machine is under the control of an operator, as on paper-mill beaters, or loads where there is danger of stalling, the clutch will slip at a predetermined overload and prevent slipping and burning of belts, breaking of chains and other power-transmission equipment, overloading the motor or wrecking the driven machine.

On some applications where normally a wound-rotor motor would be used because of the starting conditions, an automatic clutch and a simple squirrel-cage type motor with across-the-line starting will meet the requirements. The cost of a 50-hp. gearmotor for 900-r.p.m output speed, with an across-the-line magnetic starter will be approximately half that for a wound-rotor motor of the same speed and a full-magnetic starter. The drive wheel on some machines is not wide enough to permit use of a belt of sufficient width for across-the-line starting. These restrictions can be eliminated by an automatic clutch, for then only running-load conditions have to be considered.

The foregoing give only a few of the possibilities of using gearmotors or automatic clutches to improve power application, reduce installation and operating costs and increase reliability. Most of the discussion has centered around flat-belt drives, but in general the suggestions apply equally well to multiple V-belt, chain and direct drives.

# Medicine for the Doctor

***Corning Glass Works tries the virtues of glass block and glass wool in a warehouse building, to find 40% reduction in required radiation, 35% in heating steam***

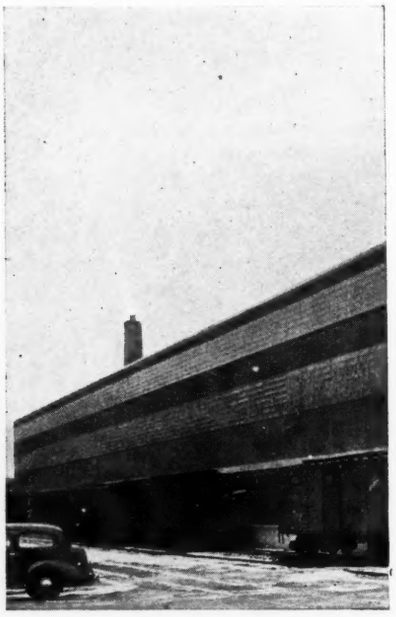
**By Alfred Vaksdal**
*Plant Engineer, Corning Glass Works*

AN INTERESTING example of savings in building and heating radiation costs is provided by the new warehouse building of Corning Glass Works at Corning, New York. L-shaped, it has temporary inside walls to provide for future expansion, hence with normal construction would provide quite a heating problem. However, by glass-wool insulation of the walls and use of glass blocks, necessary radiation, an element of first cost, and heating steam, an element of operating cost, both have been cut.

**LOSSES IN NEW SHIPPING BUILDING**
***(Transmission losses only)***

Mean winter temperature, 35 F; Inside temperature, 44 F; Maximum design temperature — 10 F

| Material | Sq. Ft. | U | Average Loss Inside 55 F Outside 35 F | Maximum Loss Inside 55 F Outside—10 F |
|---|---|---|---|---|
| Glass Block | 9369 | 0.55 | 10.000 | 334000 |
| Metal Sheathing — 4½ in. wool | 9990 | 0.06 | 12000 | 38900 |
| Double wall brick — 4½ in. wool | 10700 | 0.05 | 10700 | 34800 |
| Solid brick wall 8 in. thick | 5852 | 0.5 | 58520 | 190000 |
| Doors | 1900 | 0.5 | 19000 | 61700 |
| Sash | 3168 | 1.13 | 71600 | 233000 |
| Roof | 30000 | 0.3 | 180000 | 585000 |
| Ground floor | 30000 | 0.9 | 135000 | 135000 |
| Total B.t.u. per hr. loss | | | 589820 | 1612400 |
| Same as above except ordinary windows have been substituted for the glass blocks and no insulating wool is used. | | | | |
| Transmission through windows | 9369 | 1.13 | 212000 | 688000 |
| Infiltration through windows 1/16 in. crack — 7,800 ft. long. | .... | 0.45 | 70200 | 228150 |
| Metal sheathing — 4½ in. air | 9990 | 0.57 | 114000 | 370000 |
| Double-wall brick 4½ in. air | 10700 | 0.34 | 72800 | 236000 |
| Solid brick wall 8 in. thick | 5852 | 0.5 | 58520 | 190000 |
| Doors | 1900 | 0.5 | 19000 | 61700 |
| Sash | 3168 | 1.13 | 71600 | 233000 |
| Roof | 30000 | 0.3 | 180000 | 585000 |
| Ground floor | 30000 | 0.9 | 135000 | 135000 |
| Total B.t.u. per hr. loss | | | 933120 | 2726850 |
| Loss as obtained above | | | 589820 | 1612400 |
| Difference | | | 343300 | 1114450 |
| Per cent saving | | | 36.8 | 40.8 |



**"Outside" of the L-shaped warehouse building, with two 4-in. brick walls having 4-in. of glass wool between, and glass block replacing windows**

**"Inside" the L, showing temporary galvanized-sheathing and ordinary windows for ventilation. The metal wall is really double, with 4 in. of glass wool between**

Walls on Tioga Ave. and Pine St., and also the permanent end, are of brick and glass-block construction, unique in that the brick wall is really two 4-in. walls separated by 4 in. of glass wool. At every alternate 3-ft. interval, a brick is placed across as a tie, in addition to a liberal number of metal ties. Also the inside face of each brick wall is coated with ½ in. of mortar plaster to prevent possible moisture penetration and to keep the glass wool dry.

South and west sides of the building are corrugated galvanized sheath-

ing, to permit expansion, but are exceptional also in that they are double walls with 4 in. of glass wool between. Light and ventilation are provided through ordinary metal sash; the building fronts have glass-block bands instead of windows. The roof is also temporary in the sense that it is actually a sub-floor for a future fourth story, being $2\frac{1}{2}$ in. yellow pine covered by 10-year guaranteed 3-ply roofing and tar and slag. Building foundations and columns are figured to permit two stories to be added later. Area is 30,000 sq. ft. per floor, a total of 90,000 now, and eventually 150,000 sq. ft. Outside dimensions are 400 ft. by 60 ft. east and west with an "L" on the west end running north 100 ft. and also 60 ft. wide.

Transmission losses in the building, comparing standard construction and this new type of construction, are given in the Table, which also indicates infiltration through windows—a virtue of glass block is that no infiltration cracks are presented around sash, etc. Also, the Table does not show the maximum possible saving, because roof, sash, and a part of the brick wall are not insulated.

Although construction cost of this double wall was somewhat higher than that of an ordinary wall, it was not appreciably so. These glass blocks, among the first to be so used, cost $1.75 per sq. ft. in the wall, a figure which should eventually be closer to $1. Heating equipment costs about 40% less than for an equivalent uninsulated building. Insulation reduces heating cost about 35%.

## Rats and Machines

Recently, a rat's invasion of a bus structure brought about the explosion of a steam-turbine condenser.

The rat, in the course of nocturnal wandering, grounded a circuit fed by three turbines, of 4,000, 5,000 and 15,000 kw. capacity. Governors opened up to take care of overload and the two smaller turbines overspeeded and tripped out because of sudden decrease in load brought about possibly by termination of the short circuit. The 15,000-kw. machine remained on the line.

Meanwhile, because the short circuit had burned out leads to the motor driving the condenser circulating pump, flow of cooling water stopped. The governor of the 15,000-kw. turbine, however, was admitting steam to take care of load. Pressure quickly built up in the condenser, which exploded when a 30-in. atmospheric relief valve apparently failed to open.

The upper half of the cast-iron condenser shell broke in many pieces and the lower half was so cracked that an entire new shell was necessary. Tube sheet and lower half of the turbine casing were also cracked. The investigation revealed that in this particular installation there was an auxiliary turbine in addition to the motor to drive the condenser pump, but there was no automatic device to bring the auxiliary turbine into operation should the motor fail. It was reported that if there had been such a device, or had the atmospheric relief valve been in operation, the accident would probably have been averted.—Abstracted from *The Locomotive,* April, 1937.

# District Heating Today

***Members of National District Heating Assn., at its 28th annual meeting in Detroit, report on design of 12-in. main and compare operating data***

NATIONAL District Heating Assn. held its 28th annual convention at the Book-Cadillac Hotel, Detroit, May 25-28, with approximately 150 registered, and an extensive program of committee reports and technical papers, as well as the usual social program involving a get-acquainted luncheon, a dinner-dance, and several inspection trips. Membership is now 473, with 56 added last year. There was also an exhibition of district heating equipment with 18 exhibitors.

Officers elected for next year were: president, T. E. Purcell, Allegheny County Steam Heating Co.; 1st vice-president, J. R. McCausland, Philadelphia Electric Co.; 2nd vice-president, G. D. Winans, Detroit Edison Co.; and 3rd vice-president, Edward Lenz, New York Steam Corp.

Following a previously established custom, there were a number of breakfast meetings of committees and specialized groups each morning, and technical sessions each morning and afternoon, as well as the first evening.

### Distribution

The Distribution Committee gave a detailed report of the design of a 12-in. underground steam line showing five types and giving details of cost. Other papers at the session included one on "Long Distance Transmission of Steam Through an 18-in. Line," a study of "Soil Temperatures in the Vicinity of a 4-in. Underground Steam Line," and a final paper on Detroit Edison's experimental steam main construction.

Considerable speculation has been aroused recently about the possibility of generating steam at a coal mine or other source of fuel and of transporting it, like natural gas or oil, to a great distance. The paper on long-distance transmission studied this possibility, Fig. 1, and came to the conclusion, that, although it is theoretically possible to distribute steam at relatively high pressures over greater distances than is now customary, increase of heat losses with lengthening lines is a limiting factor.

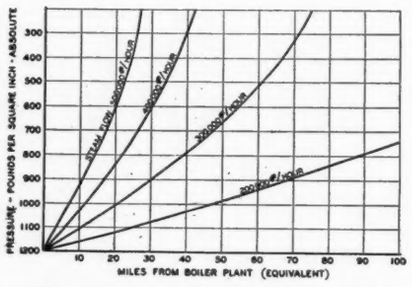



**Fig. 1—Steam pressures necessary for loads noted with no line losses**

Major factors listed that affect soil temperatures in the vicinity of steam lines, as listed in a paper by P. Chenzoff and W. A. Herr, are: Size and depth of steam line; condition of steam; kind, thickness and age of insulation; type of enclosing structure; type and dryness of soil; and weather conditions.

### Research

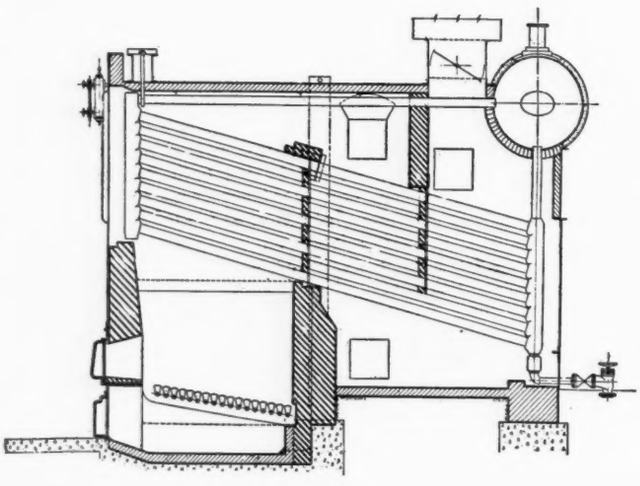
Members of the Research Committee included among their papers: "Distribution Losses," by A. S. Griswold and G. H. Kelsey; "Improving Performance of Steam-Jet Coolers," by Charles Hull; and "Steam Pumps for Raising Steam Pressures," by C. R. Erickson. Messrs. Griswold and Kelsey concluded that: (1) One important distribution loss in some cases is within the customer's building, which may be caused by condensation in long uninsulated lines ahead of service valves, tampering, and poor metering practices; (2) loss attributed to metering by different companies is not consistent; and (3) unaccounted for loss in many cases is larger than calculated heat loss from underground piping. Suggestions offered for correction were careful attention to details of installation, insulation, underdrainage, and operation.

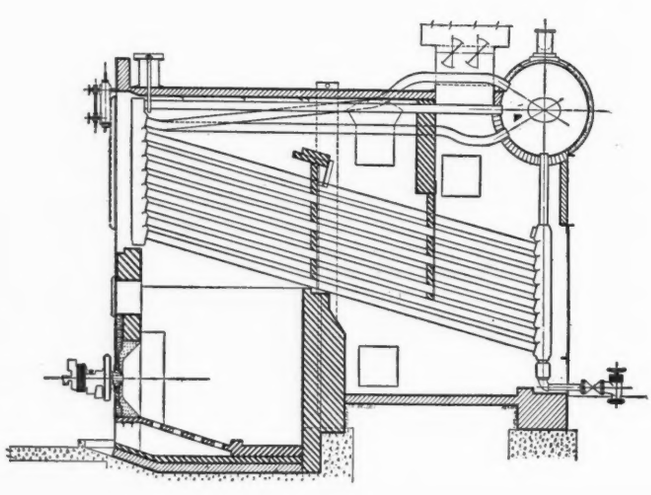
Charles Hull, Engineering Research Dept., New York Steam Corp., presented a series of recommendations on maintenance and operation of a 100-ton steam-jet cooler, having four boosters of 25 tons each. Maintenance recommendations were: maintain booster control valves tight, maintain traps in proper condition to reduce steam loss, repack valve and pump stuffing boxes, and when laying up for the off season, drain and flush the machine for a few days with air to dry it thoroughly. In operation: (1) when unit is shut down, cap air vents to maintain vacuum as long as possible; (2) operate machine at fixed steam pressure which should be as high as minimum dependable pressure that supply will allow; (3) operate machine at the highest flash-tank temperature at which air-cooling requirements will be satisfied; and (4) the automatic booster should be restored to proper operating condition. These recommendations effected a saving of 35½% in one installation.

The report by the Meters and Accessories Committee was divided in three sections: "A Description of a Demand Attachment for Shunt Flow Meters," by Charles Pohlig, Union Electric Light and Power Co.; "A Report on the New Isometer Flowmeter—Part 2," by E. A. Lueky and A. S. Griswold, Detroit Edison Co.; and "Tentative N.D.H.A. Specifications for Improvement in Steam Metering," by W. W. Stevenson, Alle-

**Fig. 2 (left)—Schematic diagram of old hand-fired, cross-drum, straight-tube boiler owned by Boston Electric Illuminating Co.**

**Fig. 3 (right)—Conversion of hand-fired coal to automatic oil-burning. Note change of top row of generating tubes (see Fig. 2) to circulating tubes which increased circulating-tube capacity and permitted lower boiler and header pressures while still meeting previous demand**





gheny County Steam Heating Co. The first paper described two inexpensive attachments, using a steam-pressure recording gage and a St. John clock and ribbon-drive assembly, for attaching to shunt steam flowmeters which will give important demand information.

The second paper is part two of a study begun at last year's meeting and presents accuracy test data on the new isometer flowmeter. The third and final paper in the Meters and Accessories Session presented a list of ten tentative specifications for improving metering and measurement of steam flow.

### Hot Water

The Hot Water Committee presented two papers. The first, "The Present Status of Heat Unit Meters," dealt with efforts being made to develop a B.t.u. meter and described in detail the two units made by Bailey Meter Co. and Republic Flow Meter Co. The second paper, "Novel Heating System Adapted for District Steam Service," described a 52-yr. old hot-water heating system in the Boston County Courthouse which last year was converted to district steam service.

### Steam Engineering

The report of the Steam Station Engineering Committee included two papers and a series of experiences reported by various member companies in answer to pressing problems of the day. G. C. Eaton, Head, Mechanical Technical Engineering Div., Generating Dept., Edison Electric Illuminating Co. of Boston, described the change-over of this compiany's steam heating plant from hand-fired coal to automatic heavy oil. The boiler plant, installed in 1913, consisted of four hand-fired, cross-drum, straight-tube boilers. A cross-section of one of these boilers prior to changes is shown in Fig. 3. Oil burners selected for the converted plant are equipped with so-called "spinning cup," integral automatic oil heaters, and "viscosity valves." Cross-section of a modernized boiler is shown in Fig. 4.

The second paper, "Modern Power Plant Piping," by E. A. Kirbey, showed proper ways of welding pressure piping, methods for attaching nozzles to headers, and design of welding grooves for butt welds. Fig. 5 shows three methods of attaching nozzles to headers, of which method *A* is the recommended one.

### Operation

Some interesting operating experience sketches were submitted in answer to twelve questions asked by the Committee. Questions were asked on operation and maintenance of evaporators, improving combustion, removing siftings from stoker air chambers, boiler blowdown, experiences with boiler gas baffles, getting oxygen out of feedwater, application of blowdown heat, exchangers, experiences with extraction-type turbines, production of dry steam at the boiler outlet, relocation of fans with respect to cleaning equipment, evidences of boiler carry-over in the discovery of deposits in utilizing systems, and packing of pumps and other equipment.

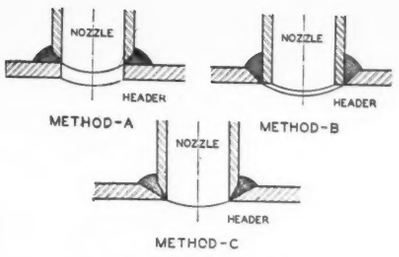



**Fig. 4—Three methods for attaching nozzles to headers**

Most of the companies that answered the question on removing oxygen from feedwater use both mechanical and chemical deaeration, although Edison Electric Illuminating Co. of Boston stated that the mechanical deaerators they use are so effective, even with 85% makeup, that it has never been necessary to use a supplementary sulphite treatment. New York Steam Corp. reported use of mechanical deaerators in all its plants with chemical treatment in addition at the Kips Bay and 60th St. Stations. Sodium-sulphite treatment has checked a pin-point pitting that was occurring in the drums.

### Stoker Siftings

Philadelphia Electric Co. reported that it disposes of stoker siftings in its boilers through a drain pipe from the stoker plenum chamber into an ash car under the ash hopper. Siftings are removed separately and stored at a convenient location in the station yard until a sufficient quantity have accumulated to justify returning them to boilers. New England Gas & Electric Assn. removes siftings in the main air box at 6- to 7-week intervals when a boiler is down for maintenance of stoker grates.

Detroit Edison has built sifting hoppers in plenum chambers under all latest stokers. Clean-out pipes from these hoppers lead outside of plenum chambers so siftings may be removed without interruption to boiler operation. A larry, holding approximately one ton, which can be wheeled by two or three men, is used to collect siftings which are returned to coal bunkers.

### Blowdown Heat Exchangers

Three companies reported use of blowdown heat exchangers with good results. New York Steam Corp. uses five units at Kips Bay Station, and recovers heat equivalent to nearly 1% of total boiler output. Detroit Edison stated that two of its plants use heat exchangers to recover nearly all heat in blowdown water sent to the sewer. Cooling medium is treated water on its journey to deaerating heaters. Boston Edison uses a blowdown heat exchanger in one plant which has continuous blowdown to heat incoming feedwater a few degrees. It reported that although the saving is only a fraction of a per cent, it is a real saving.

The question concerning maintenance and operation of evaporators in localities where raw-water supply is unsuited to direct feed brought answers from Philadelphia Electric and Allegheny County Steam Heating Co. The latter uses submerged-coil evaporators in one plant, and had to devise a special method for removing cracked scale. By installing internal piping to distribute incoming water through nozzles at each end of the shell directed to flush accumulated scale from bottom of the shell to blowdown outlets, operation has been so improved that it is not necessary to remove evaporators for cleaning. Philadelphia Electric does not use evaporators as less than 2% makeup is used in its generating stations.

New York Steam Corp. and New England Gas and Electric reported experiences with extraction-type turbines, and both agreed that extraction auxiliary steam turbines have advantages in flexibility and ease of operation. The former quoted results of a test in which a saving of 2.6% in auxiliary steam was made by using extraction turbines for auxiliary drive. New England Gas and Electric stated that extraction turbines have advantages of being able to take sudden and unexpected heating loads at any time and also permitting use of generator for power-factor correction.

### Packing

Johns Hopkins reported best results with semi-metallic packing for boiler-feed pumps. The Philadelphia Electric generating station, which produces high-temperature steam, uses a long-fiber asbestos with monel wires for a binder in packing valve stems. For lower-temperature steam up to 500 F, it uses a long-fiber asbestos packing impregnated with high-flash oil and given a graphite bath between each braiding process. Detroit Edison replaces packing at regular intervals—new gaskets are installed in pipe joints whenever they are opened. All other places where packing is used are given a thorough inspection every summer. For valves, additional packing is installed if stuffing boxes permit. Complete new packing is installed in boiler-feed pumps and other important units once each year.

The Chemistry Committee report included: "Steam Purity—Limitations of Present Methods," by Louis Shnidman, "Pretreatment of Coal for the Prevention of Slag Formation on Boiler Tubes," by Harold Farmer, "Activities of the Joint Research Committee on Boiler Feedwater Studies During the Past Two Years," by C. H. Fellows, and "Corrosion Studies in Steam Heating Systems," by Prof. R. R. Seeber, Michigan College of Mining and Technology.

### Slag Formation

The first paper described methods and apparatus for determining steam purity. Harold Farmer concluded that as yet no convincing pretreatment of coal for prevention of slag formation is available. He expressed the opinion that materials with calcium chloride as a base will only find application in powdered fuel because the low-melting material dropping from tubes would be detrimental to stoker-furnace fuel beds. The other two papers were technical discussions of research activities carried on by the Chemical Committee.

# Speaking of Power . . .

LAST YEAR, on a German ship coming back from England, I met an Irish-American who had been working in a German sugar refinery in Dublin, and he told me what a Czechoslovakian thought of an English engineering paper published in Germany. . . . This Hibernian complexity reminds me a bit of the "Conte Rosso". The Italian liner, making frequent trips to China, has achieved increased speed and economy by installing a high-pressure Czechoslovakian boiler (Loeffler) and Swiss high-pressure turbines (Escher Wyss). The story, by the way, was recently told at a meeting of English marine engineers by the London licensee of the Czechoslovakian company. While nations make faces at each other over fences of bayonets, science and engineering remain international. . . .

. . . . over fences of bayonets

Incidentally, I wonder when some American builder is going to install a high-pressure "top" on an American ship. And when I say high pressure, I don't mean 500 lb.

Here is a strange thing when you stop to think of it. More than half of the attention given to steam generation in the meetings of engineering societies is devoted to central-station boiler rooms. Yet both in steaming capacity and in coal burned annually, industrial boiler rooms in the aggregate outweigh them at least three to one . . . Even this ratio is an inadequate measure of the true situation, because the object of engineering studies is to improve practice, not merely to record it. Thousands of industrials could easily cut their fuel bill 25 to 50% by using less steam made with greater efficiency from cheaper coal. Considered nationally, there are easily ten dollars to be saved in industrial steam generation for every salvageable utility fuel dollar . . . If this is true, why doesn't the industrial steam plant get more professional attention? The answer must be that the utilities are more highly organized along technical lines, and in general, staffed with engineers of more highly specialized technical training. Backed to the limit by management, they spend their lives trying to squeeze the last economic B.t.u. out of each pound of coal . . . Meanwhile, a yearly industrial steam fuel bill of six or seven hundred millions of dollars patiently awaits the engineering attention it deserves.

. . . . bill patiently awaits

Because industrial fuel dollars are spread among thousands of plants, many engineers fail to grasp their importance. Now and then, though, we find a spectacular example. Such is Weirton Steel (see page 370). About a year ago Weirton started operation of a high-pressure top involving a 10,000-kw. turbine and two modern 400,000-lb. per hr. boilers with automatic combustion control. . . . The coal *saving* (not consumption), has averaged 15,000 tons a month. "A pretty penny", any Scotchman would admit.

. . . . "a pretty penny"

In a recent meeting, L. C. Morrow, editor of *Factory,* got to the roots of the present economic situation. Very much condensed, his idea is this: Three forces speed *recovery:* the natural expansion following depression, government pump-priming expenditures, and world-wide armament races. But three other forces restrict *profits:* rising raw material prices, rising labor costs, and obsolete production equipment. . . . Executives wonder how far they can pass the increased expenses along to customers. Certainly there's a limit. Some competitor may take the business. Another industry may compete (e.g., increased coal prices would encourage the use of oil and gas or vice versa). Buyers will "strike" if prices get too high. . . . What to do to avoid profitless prosperity? High wages will not make prosperity if prices are correspondingly high. The only real solution, says Morrow, is a combination of reasonable prices and high wages. Outside the field of magic, this can be accomplished only by high efficiency in production and distribution. Here is something that any man can figure out for himself. First, use better machinery, more intelligently, to get full value out of the labor dollar. Then cut the cost of distribution.

. . . . any man can figure out

You'll have to look back ten or fifteen years to find engineering progress equaling today's. All around us the seeds of solid thinking, sowed during the depression, are sprouting into steel, brick and concrete. Several examples will be found in this number of *Power*. . . . Here and there, across the country, superposed plants are going into operation. Central stations have pointed the way, as they did more than a decade ago with the straight high-pressure plant. And now, as then, some of the larger and more progressive industrials follow suit with noteworthy savings. . . . Twelfth Street, Richmond, Va., (page 362) is a good example of a utility "top". The story of Weirton (page 370) tells how an industrial saves 15,000 tons of coal monthly by applying the same general ideal. . . . In the diesel field, New York University's plant (page 374) illustrates the trend to combined steam-diesel plants, while Endicott (page 381) shows how a modest B.t.u. salvage from diesel exhaust can be turned into real dollars on the balance sheet. . . . Corning (page 388) contributes a double-wall building construction, packed with glass wool, that cuts heating bills 30 per cent. Louis Elliott (page 394) shows what a modern outdoor pipe line looks like. On Page 393 you can see a boiler slag tapper caught tapping. . . . These are just samples, picked from the swiftly moving stream of today's power engineering. Future numbers will have a lot more to reveal.

. . . a lot more to reveal

PHIL SWAIN
*Editor*

Starting

Running

The Plug

# SLAG TAP

Ready to Plug

IN 1930, when South Amboy Station of the Jersey Central Power & Light Co. went into operation, the slag-tap furnace bottoms were not provided with any means of cooling. These bottoms gave trouble from time to time from slag leaking through the bottom, also from expansion that forced bottom waterwall headers out of position. In 1933, furnace bottoms of two of the three 280,000-lb. per hr. boilers were reconstructed and provided with water cooling. The drawing shows present construction. The $3\frac{1}{4}$-in. O.D. water tubes on 6-in. centers run from front to back of the boiler and are tied into the boiler circulation. Under the tubes and supported on the bottom steel plate of the furnace are 2 to 3 courses of firebrick. On top of the firebrick and packed around the tubes is dry magnesite. Next comes a layer of magnesite liquid high-temperature mixture which due to the slope of the tubes and furnace bottom varies in depth above the tubes from 1 to 3 in. On top of this was a 3-in. layer of plastic chrome, which lining lasted 2 to $2\frac{1}{2}$ yrs., and has been replaced by a similar material. Sufficient time has not yet elapsed to determine the life of this material, which is still in good condition.

The furnace bottom is sloped $\frac{1}{8}$ in. to the foot from front and back wall to the center. Water-cooled slag spouts approximately at the center line of each side wall are $6\frac{3}{4}$ in. wide and 16 in. high. They are at the boiler-room floor elevation and provided with hydraulically operated gates. The molten slag is discharged in front of twelve $\frac{1}{4}$-in. water jets, which cool and break up the slag as it passes into a rectangular sluice-way lined with ash-colite. This later joins a pipe sluice and additional jets carry the slag to an ash pit from which it is pumped for fill.

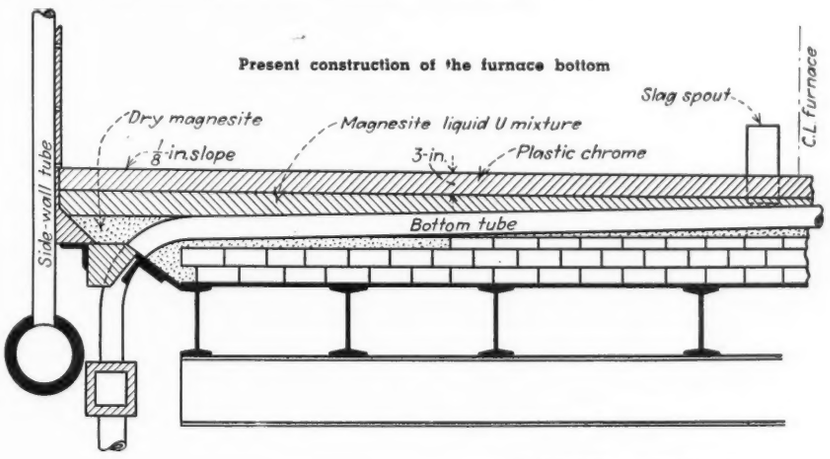
The boilers, which generate steam at 1,400 lb. pressure and 750 deg. F, are tapped every morning about 9 a.m. except Saturdays, Sundays and holidays. Normally, the operation requires about 2 hr., and is complete at 11 a.m.

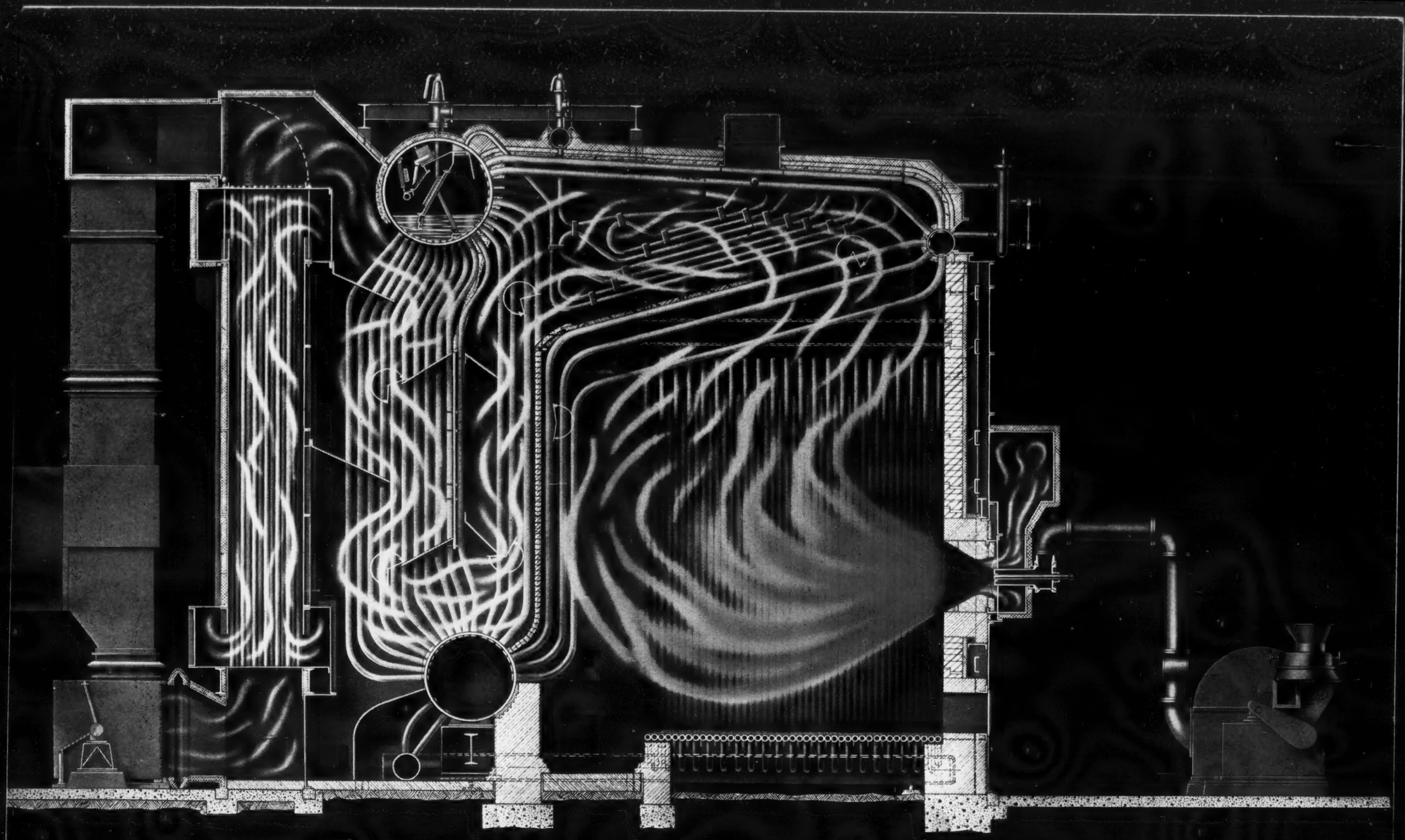
With the coal used (ash fluid point 2,400 F) it is usual to have the boiler steaming at about 185,300 lb. per hr. to insure fluid ash. The furnace is 18 ft. 10 in. front to back and 27 ft. $7\frac{1}{4}$ in. wide giving a volume of 12,900 cu. ft. so that at the above steaming rate, heat release in the furnace is 18,500 B.t.u. per cu. ft. per hr. Normally, there is about 9 in. of slag above the lining at the start, and this is drawn down to about 6 in.

The first step in tapping is to start the 1,600-g.p.m. ash-pit pump, which will handle 15% of slag by volume. The 2,000-g.p.m. sluice pump interlocked with the ash-pit pump can then be started. With both pumps running satisfactorily, the operator may raise the hydraulically operated gate on one slag spout, exposing a fireclay plug placed in the spout at the end of the previous tapping. A hole must be knocked through this before slag will start to run. Usually the plug knocks through easily, but sometimes if the plug has leaked or if tapping has been delayed too long, an air hammer is required to start the slag.

When sufficient slag has run out, a ball of plastic fireclay about 6 in. in diameter is pushed into the spout. The gate is then lowered. When this has been completed for the boilers that are steaming, the sluice and ash-pit pumps may be shut down.

Present construction of the furnace bottom





# THE NEW RILEY TYPE "RP" BOILER UNIT

## MOST MODERN OF STEAM GENERATING UNITS

# MOST MODERN OF STEAM GENERATING UNITS

## *for steam capacities from 20,000 to 150,000 pounds per hour*

To meet the demand for steam generating equipment requiring a minimum initial investment both as to equipment and building for housing, Riley engineers developed the Riley Type "RP" Boiler Unit.

In the development of this outstanding unit, the major consideration was to design a unit incorporating all of the features which had proven correct during years of operating service, of large Riley Steam Generating Units . . . but which could be manufactured and installed at reduced initial investment costs. No sacrifice in performance, reliability or satisfaction was tolerated to arrive at a design of lower investment.

As a result, the design of the Riley "RP" Boiler Unit very closely follows the characteristic design of large Riley Boilers, assuring the same satisfactory performance, the same rapid unrestricted unidirectional circulation, the same reliability, the same superheater characteristics, equally high efficiencies. Riley has not reduced the initial investment by cheapening the construction or design in any way.

The satisfactory performance of existing installations has definitely proven the correctness of design of Riley "RP" Boiler Units. In justice to yourself and your company you should thoroughly investigate Riley Type "RP" Boiler Units.

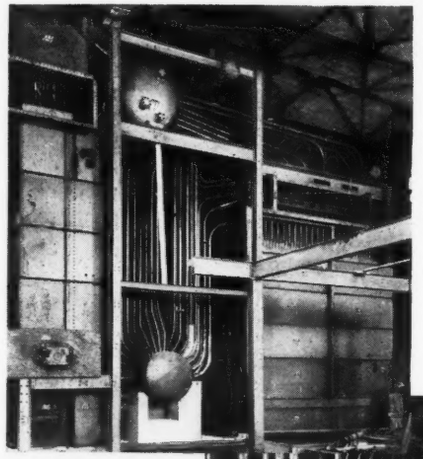


Photo of partly erected Riley "RP" Unit. Note large height differences between upper and lower drum. Also rugged steel casing.

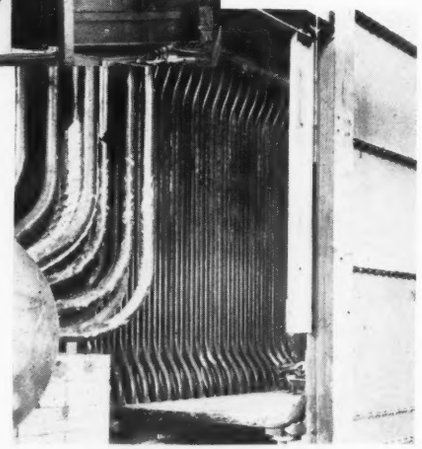


Photo of furnace of Riley "RP" Unit. Note how close spaced tubes form virtually a solid wall and floor.

PHOTOGRAPHS DURING ERECTION
RILEY TYPE "RP" UNITS
NEWPORT ELECTRIC CORP., R. I.

## *having these distinctive advantages*

HIGH EFFICIENCY

High efficiency results from rapid positive circulation, cross flow of gases over heating surface, large area of tube surface exposed to radiant heat, low flue gas temperatures, proper arrangement of baffles and proper co-ordination of boiler and fuel burning equipment.

RAPID POSITIVE CIRCULATION

The design of the Riley Type "RP" Boiler is based on the ring flow unidirectional principle of circulation. The great distance between upper and lower drum results in a large flow-producing head.

CROSS FLOW OF GASES

Riley Type "RP" Boilers are baffled so as to give cross flow of gases over the boiler heating surface, resulting in high heat transfer rates.

LOW FLUE GAS TEMPERATURES

The use of 2½" O. D. tubes in the last tube bank makes possible a large amount of heating surface which, together with rapid circulation and cross flow of gases, assures unusually low flue gas temperatures.

DRY STEAM

Steam delivered to the upper drum enters above the water line which, together with the efficient Riley Steam Separator, assures dry steam at all ratings.

EXTREME LOAD FLUCTUATIONS

Extreme load fluctuations are easily carried with Riley Type "RP" Units because of the large amount of tube area exposed to radiant heat and rapid boiler circulation.

CLOSE SPACED WATER WALLS AND FLOORS

3¼" tubes on 3⅜" centers, presenting practically a solid water wall surface, are used in the side walls and floors.

LOW MAINTENANCE

Rapid positive circulation assures a minimum of boiler maintenance. The use of close spaced water walls eliminates refractory maintenance.

ASH EASILY REMOVED

When Riley "RP" Units are fired with pulverized coal, granular ash is formed. This ash can be easily blown with air or steam lance to the ash pit at the rear of furnace where it is easily removed.

ADAPTABLE TO LIMITED SPACE

Riley Type "RP" Units are adaptable to existing boiler houses where space, especially height, is severely restricted.

A FEW REPRESENTATIVE USERS OF RILEY "RP" UNITS

Guide Lamp Co., General Motors Corp., Anderson, Ind.
1-50,000 - 275 lbs. - 577°F
Bemis Bag Co., Peoria, Ill., 1-70,000 - 275 lbs. - 600°F
Newport Electric Co., Newport, R. I., 2-60,000 - 275 lbs. - 765°F
Utilities Pr. & Lt. Operating Co., Engrs.
General Aniline Co., Rensselaer, N. Y., 1-80,000 - 250 lbs. - 475°F
Riverside Metal Co., Riverside, N.J., 1-65,000 - 450 lbs. - 516°F
Wheeling Steel Co., Wheeling, West Va.
C. W. E. Clark, Engrs., 1-100,000 - 660 lbs. - 650°F
Central Ohio Pr. & Lt. Co., Findlay, Ohio
Sargent & Lundy, Engrs., 2-60,000 - 450 lbs. - 825°F
Hartford City Paper Co., Hartford City, Ind.
A. B. Kinney, Engrs., 1-55,000 - 350 lbs. - 600°F
Lewiston Bleachery, Lewiston, Me., F. P. Sheldon & Sons,
Chas. T. Main, Engrs., 1-70,000 - 450 lbs. - 660°F
Hellwig Silk Dyeing Co., Philadelphia, Pa.
J. G. Berger, Engr., 1-100,000 - 475 lbs.
Great Lakes Steel Corp., Ecorse, Mich., 2-75,000 - 450 lbs. - 700°F

# RILEY

STOKER CORPORATION
WORCESTER, MASSACHUSETTS

COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS
PULVERIZERS - BURNERS - STOKERS - WATER-COOLED FURNACES
STEEL CLAD SETTINGS

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore St. Louis
Cincinnati Houston Chicago Milwaukee St. Paul Kansas City Los Angeles Atlanta New Orleans

Steam and condensate piping at the Deepwater end, showing a roadway crossing with clearance of about 25 ft.

# A Mile of 700

***4900-ft. cross-country pipeline carries up to 200,000 lb. per hr. of 350-lb., 700-F steam from gas-fired Deepwater Station, Houston, Tex., to Champion Fibre & Paper Co.***

HOUSTON Lighting & Power Co. has contracted to supply, to Champion Paper & Fibre Co., 350-lb. steam up to a maximum of 200,000 lb. per hr.; the steam will generate electrical energy in Power-Company turbo-generator units in the Paper Company's plant, and turbine exhaust and bleed will be utilized for process. Two turbo-generators are provided, rated 4,000 and 5,000 kw. respectively, designed for steam extraction at one point; the former machine exhausts at 30 lb. gage and the latter to a condenser. Warm water for process is to be taken as required from this condenser. While most of the steam required for paper process is supplied through the Power-Company turbines, the Paper Company has installed some boiler capacity, to make use of mill wastes as fuel.

The Champion plant is on Houston Ship Channel, a short distance below the Power Company's Deepwater station. This station, a few miles outside Houston, Texas, supplies power for the city and vicinity. Installed capacity is 147,000 kw., including 135,000 kw. of 350-lb. equipment and 12,000 in a 1,300-lb. superposed unit.

### Mutual Aid Contract

When construction of the Champion Paper & Fibre Co. plant was announced, it occurred to the management of Houston Lighting & Power Co. that an arrangement might be made between the utility and industrial companies, advantageous to both parties, for supply of steam and electrical energy for the new mill. Such a contract would materially reduce investment in steam plant for Champion, and would permit Deepwater to bring into active use 350-lb. boiler capacity then serving as reserve. Electrical energy required by the Paper Company, in excess of that produced by turbines in the Champion plant, would be supplied directly from the Houston Lighting system; on the other hand, any excess generation by turbines in the Champion station could be delivered into Houston power system. Such a contract was consummated.

Industrial-utility relationships of this character are more complex than the usual contract for sale and purchase of electrical energy, and the best commercial and engineering ability was applied to the problem, during the negotiations, to the end that terms of contract should be fair to both parties.

Vinces Bayou crossing, with the piping carried on timber supports

### Cross-Country Pipeline

A feature of this inter-company connection is the pipeline carrying steam from the Deepwater station to Champion mill. The distance along the line is about 4,200 ft. A 14-in. pipe carrying 350-lb. steam is about 4,900 ft. long including bends, and a 4-in. for return condensate, 4,500 ft. long.

Both pipes are of Grade B seamless steel, ASTM A-106. Steam pipe is $\frac{3}{8}$ in. thick and condensate pipe ASTM, Schedule 40. Pipe flanges are dimensioned and drilled in accordance with ASA B-16e, for 400 lb. on the steam line and 300 lb. on the condensate line. All flanges are ASTM A-105-33, Class B. Bolts on steam lines are alloy steel, ASTM A-96-33, Class C; on the condensate line, commercial steel.

Piping was delivered in approxi-

A low portion of the line carried on structural supports, showing hanger details, insulation and expansion bends

# -Deg. Steam

**By Louis Elliott**
*Consulting Mechanical Engineer*
*Ebasco Services Incorporated*

mately 40-ft. lengths. Joints are butt-welded, with ends beveled to 30 deg., and with chill rings for steam pipe. Lengths were specified to be short by two-thirds of the calculated expansion before welding. The hydraulic test specified for steam pipe was 800 lb. and for condensate line 600 lb.

### Expansion Joints

Expansion is taken up largely by means of bends; for the 14-in. line, each of these consists of 12-ft. tangents and corner bends with 6-ft. radius. The pipeline is laid out in six main tangents; points of deflection are utilized to take up some expansion and contraction, but the major portion of change in length, resulting from temperature change, is compensated for by expansion bends. Calculation for expansion joints is based on a change of length in the steam line of 6 in. per 100 ft. and in the condensate line of 2 in. Anchorages are provided, along tangents, at varying intervals, depending upon the route of the pipe; on some of the longer tangents, for instance, these anchorages occur at intervals ranging from about 250 to 400 ft. for the 14-in. line.

Drainage is provided at three low points in the pipeline, by 2-in. valved connections tapping into the pipe; no traps are used.

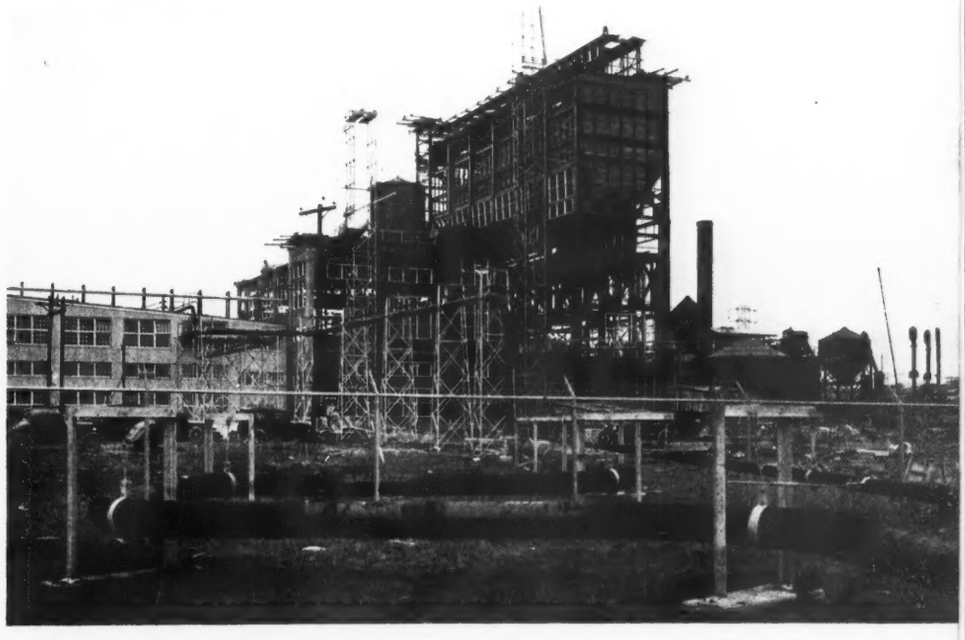
Steam-line insulation consists of 1½ in. of high-temperature material and 2 in. of 85% magnesia; for the condensate line 2-in. of 85% magnesia is used. Weatherproof covering is close-weave rag felt with mica surface, asphalt-saturated and secured in place by galvanized-iron wire.

The pipeline traverses rather flat country, the course being roughly parallel to Houston Ship Channel. For a good part of the length, supports consist of galvanized structural-steel frames on concrete piers; across a bayou and the nearby swampy region, pile-supported timber frames are utilized. A total of about 190 supports are required, the average distance between points of suspension being 22 ft. Pipes are swung in galvanized-steel hangers, each with turnbuckle. Some spring hangers are used, and at certain points horizontal braces, to prevent swinging. For the larger part of the distance, pipes are hung to clear ground surface by 1 or 2 ft.; clearance above roads is about 25 ft., and at one bayou crossing clearance above normal water is 35 ft.

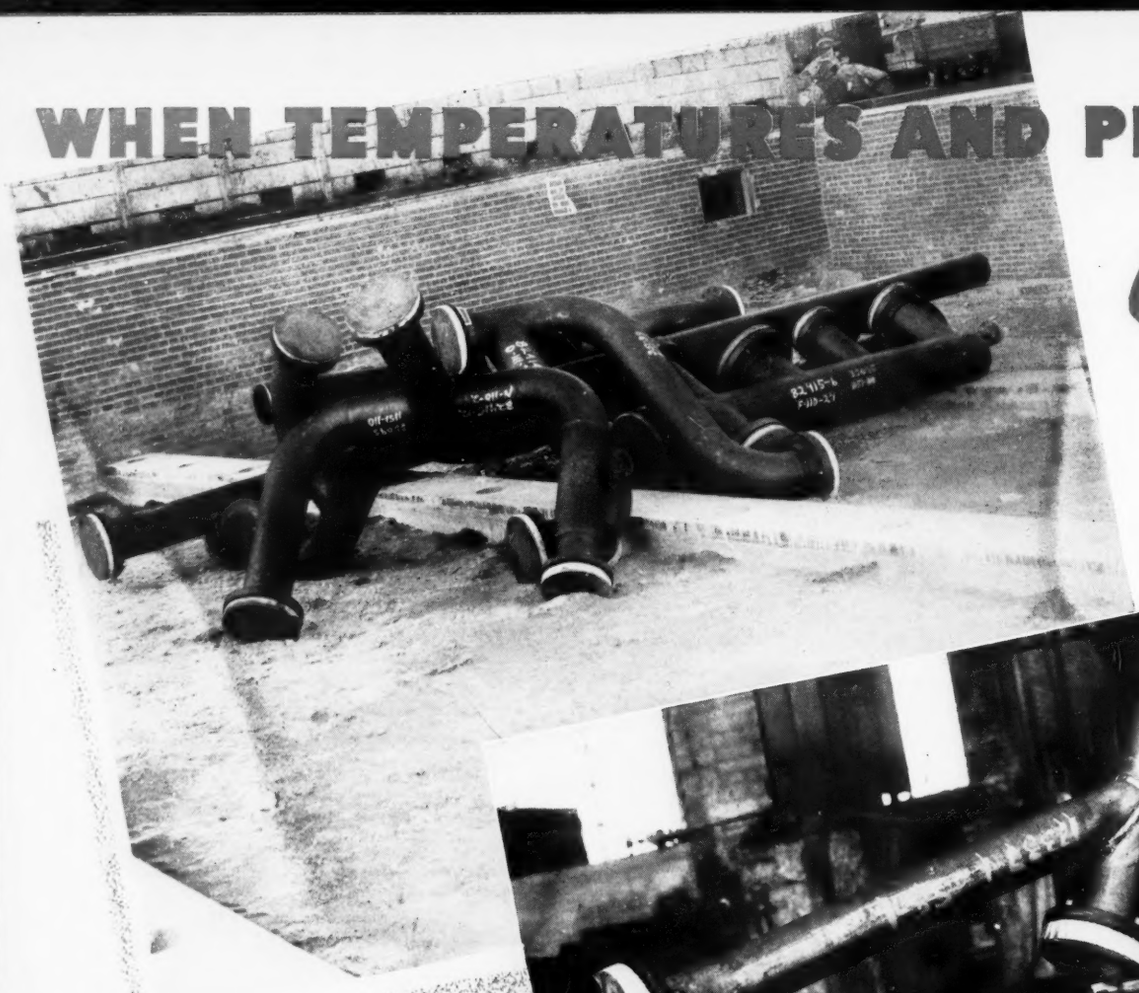
Design of supports assumed wind velocities of 100 mi. per hr. Because of the character of topography traversed, of diversity of foundation conditions, and of special right-of-way requirements, a large variety of special designs had to be utilized for supports. Approximately 30 general and detailed drawings were required to delineate pipelines and supports.

The intent in drawing up the design was to provide, at relatively low cost, a line capable of giving reliable service and entailing only moderate maintenance expense. The pipeline was designed and fabricated and erection completed within nine months, which, considering conditions to be met, constituted a short schedule. The contractor for pipelines was Wyatt Metal & Boiler Works of Houston. Ebasco Services Incorporated acted as consulting engineers for Houston Lighting & Power Co. on this work.

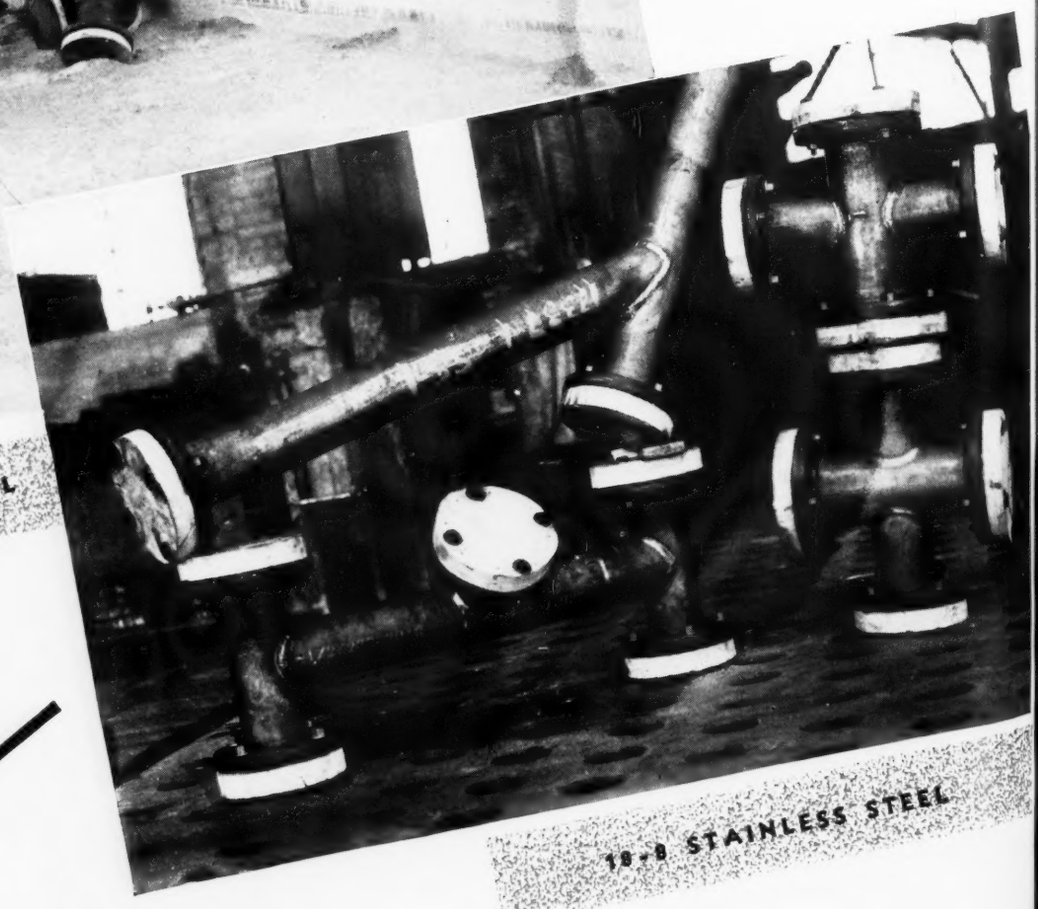
Uncovered pipeline rising to enter the Champion plant; taken during construction



# WHEN TEMPERATURES AND PRESSURES *Give*



SAE 2-3% NICKEL STEEL



18-8 STAINLESS STEEL

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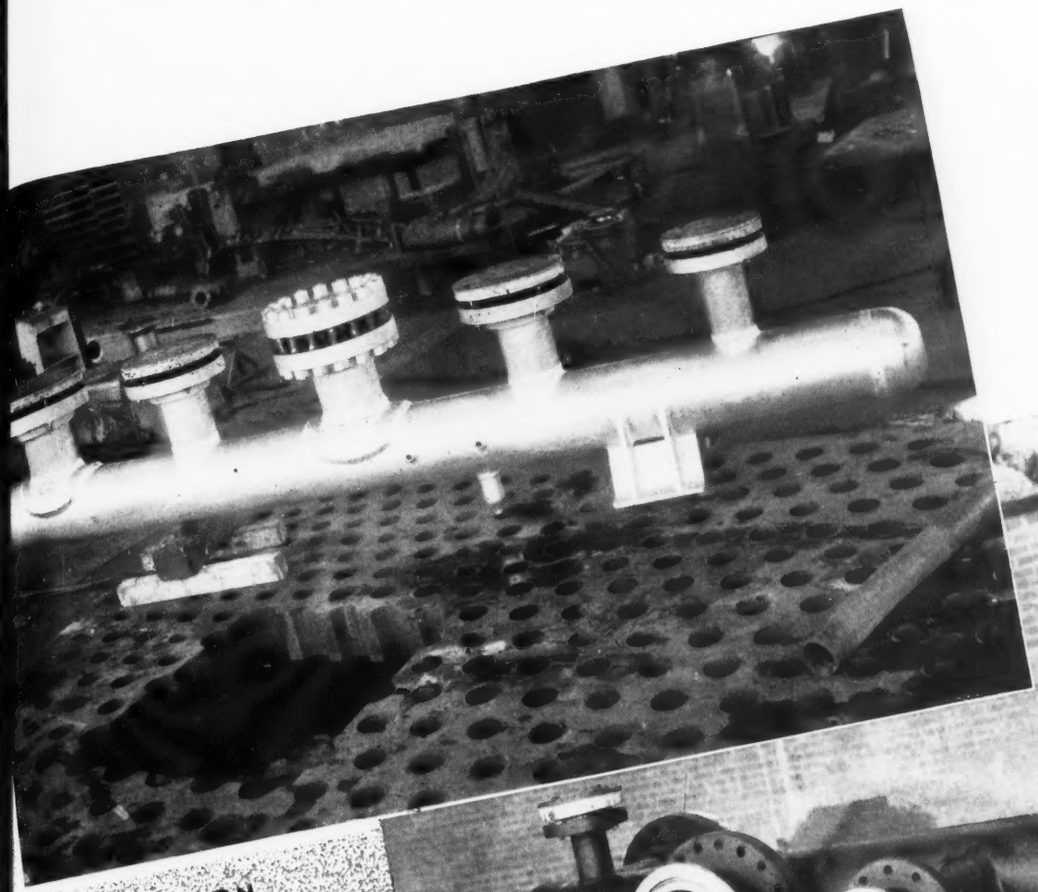
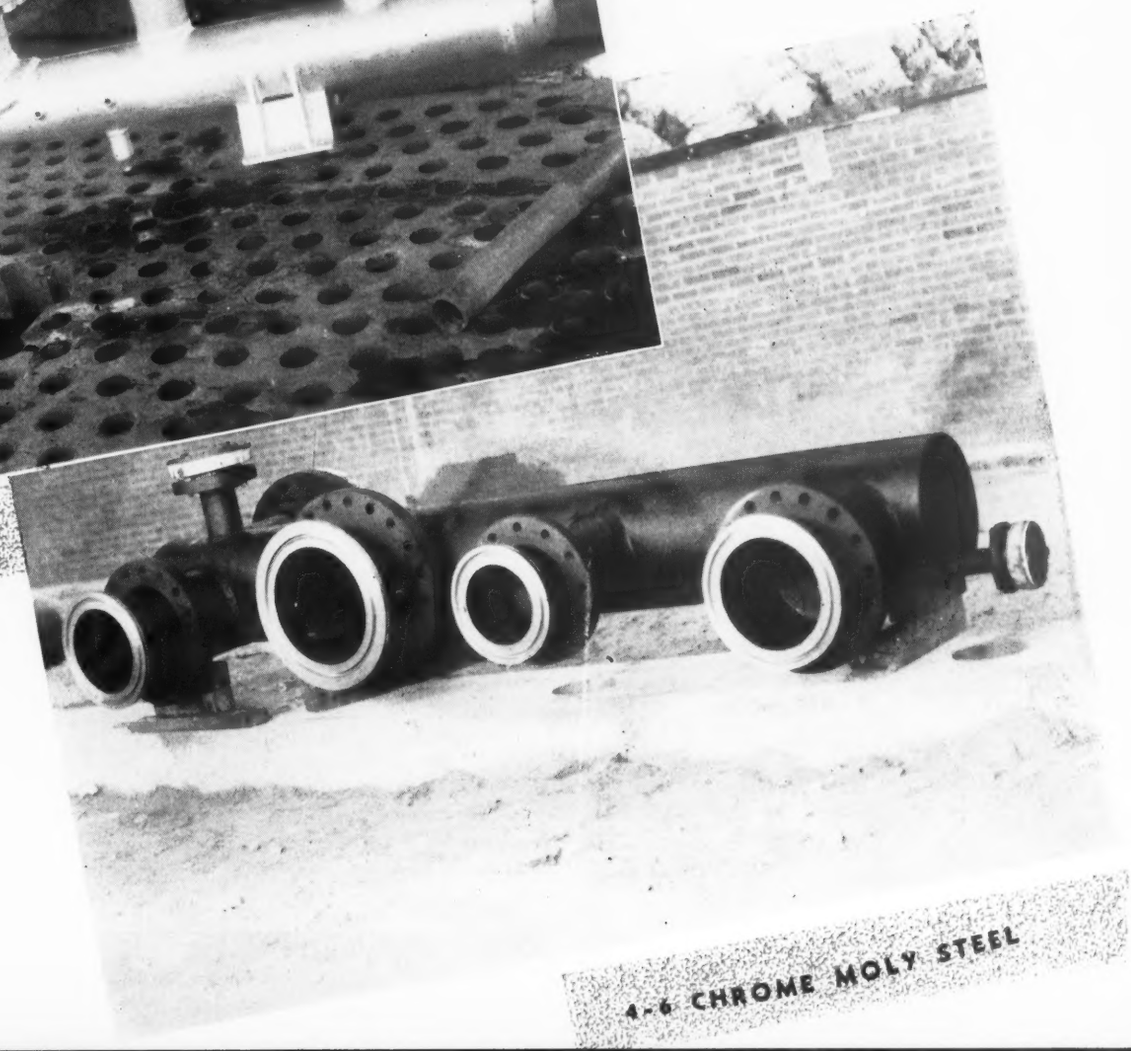


CARBON MOLY STEEL

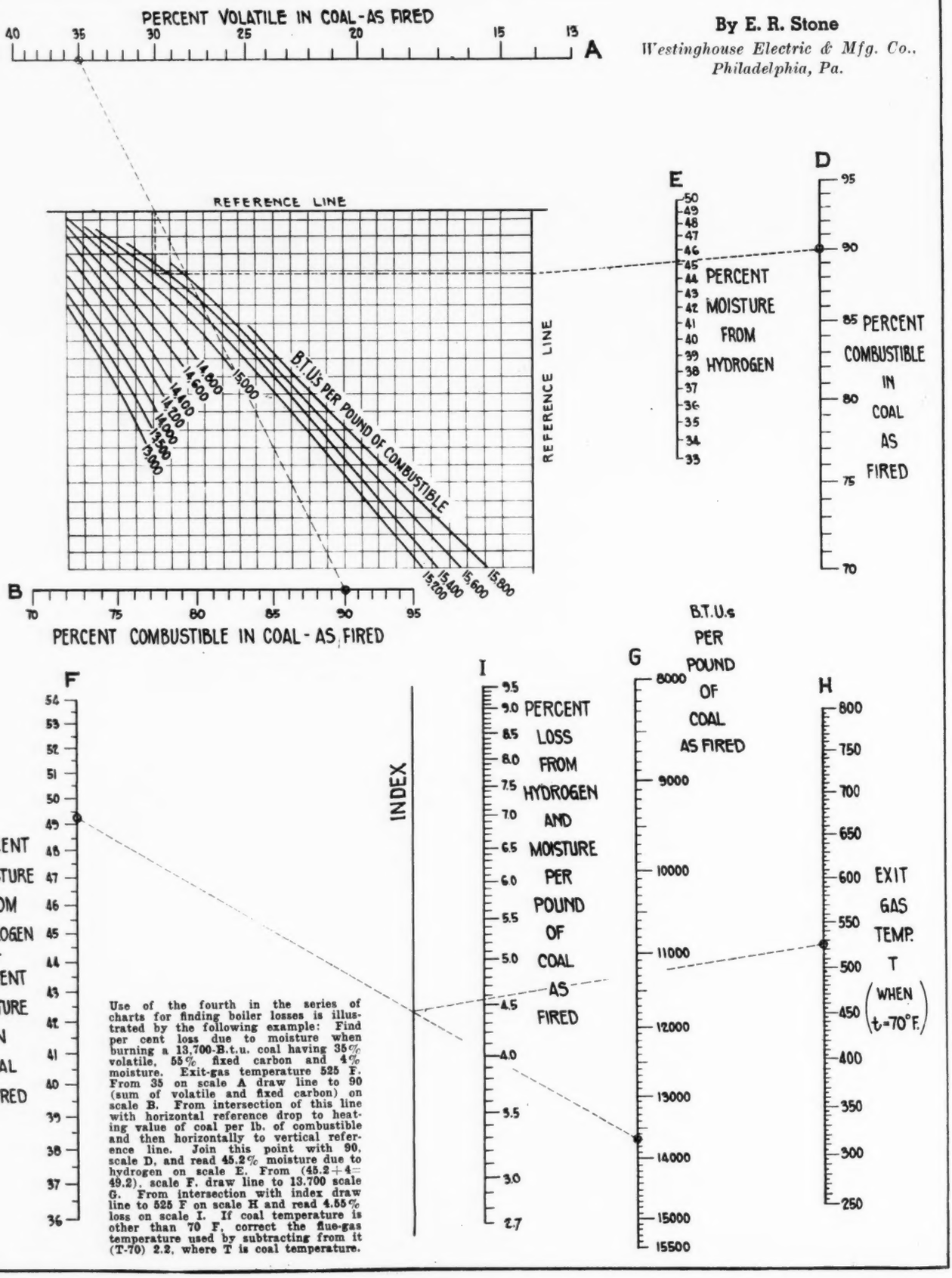


4-6 CHROME MOLY STEEL

Number 59

# Loss Due to Moisture and Hydrogen

By E. R. Stone
*Westinghouse Electric & Mfg. Co., Philadelphia, Pa.*


PERCENT VOLATILE IN COAL - AS FIRED
40 35 30 25 20 15 13
A
REFERENCE LINE
B.T.U.'s PER POUND OF COMBUSTIBLE
14,800
14,600
14,400
14,200
14,000
13,800
13,600
15,000
15,200
15,400
15,600
15,800
REFERENCE LINE
B
70 75 80 85 90 95
PERCENT COMBUSTIBLE IN COAL - AS FIRED
E
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33
PERCENT MOISTURE FROM HYDROGEN
D
95 90 85 80 75 70
PERCENT COMBUSTIBLE IN COAL AS FIRED
F
54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36
PERCENT MOISTURE FROM HYDROGEN + PERCENT MOISTURE IN COAL AS FIRED
INDEX
I
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.7
PERCENT LOSS FROM HYDROGEN AND MOISTURE PER POUND OF COAL AS FIRED
G
B.T.U.s PER POUND OF COAL AS FIRED
8000 9000 10000 11000 12000 13000 14000 15000 15500
H
800 750 700 650 600 550 500 450 400 350 300 250
EXIT GAS TEMP. T (WHEN t=70°F.)

Use of the fourth in the series of charts for finding boiler losses is illustrated by the following example: Find per cent loss due to moisture when burning a 13,700-B.t.u. coal having 35% volatile, 55% fixed carbon and 4% moisture. Exit-gas temperature 525 F. From 35 on scale A draw line to 90 (sum of volatile and fixed carbon) on scale B. From intersection of this line with horizontal reference drop to heating value of coal per lb. of combustible and then horizontally to vertical reference line. Join this point with 90, scale D, and read 45.2% moisture due to hydrogen on scale E. From (45.2 + 4 = 49.2), scale F, draw line to 13,700 scale G. From intersection with index draw line to 525 F on scale H and read 4.55% loss on scale I. If coal temperature is other than 70 F, correct the flue-gas temperature used by subtracting from it (T-70) 2.2, where T is coal temperature.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*Detroit Free Press*

**Pres. James H. Herron, Dr. Chas. F. Kettering and Dr. C. F. Hirshfeld "swapping yarns" during the meeting**

# The A.S.M.E. at Detroit

***Mass production and the automobile form theme of semi-annual meeting, May 17-21, but power, fuels and feedwater papers have an important place. Harvey N. Davis nominated for president***

MORE THAN 900 engineers and their families registered for the semi-annual meeting of the American Society of Mechanical Engineers at the Statler Hotel, Detroit, May 17–21. In contrast to previous meetings, consisting of a series of sessions under the auspices of various Divisions, this meeting had as its central theme mass production and the automotive industry. General sessions each morning and evening related to various aspects of this subject in which Detroit is pre-eminent, while simultaneous technical sessions and inspection trips were held each afternoon.

During the business portion of the meeting, the Council selected St. Louis for the 1938 semi-annual meeting, and nominated th following officers: President: Harvey N. Davis, pres., Stevens Inst. of Tech.; Vice-presidents: F. O. Hoagland (1 yr.), B. M. Brigman, Dean Speed Scientific School, Univ. of Louisville; Harte Cooke, mech. engr., Diesel Div., American Locomotive Corp.; W. H. McBryde, construction engineer; L. W. Wallace; Managers: Carl Bausch, vice-pres., Bausch & Lomb Optical Co.; S. B. Earle, Dean, School of Engrg., Clemson A. & M. College; F. H. Prouty, Prouty Bros. Engrg. Co.

Included in inspection trips were Connors Creek Power plant of Detroit Edison Co., Springwells Station of Detroit Dept. of Water Supply, and River Rouge power plant of Ford Motor Co. There was also a dinner dance Wednesday evening and an extensive social program. Much of the responsibility for arrangements was vested in engineers of the Detroit Edison Co., with J. W. Parker, vice-president and chief engineer, as general chairman.

Technical sessions began with a keynote address by Dr. C. F. Hirshfeld, chief of research, Detroit Edison Co., and a paper on locomotive bearings. Dr. Hirshfeld outlined the program, then contrasted practice in automotive design and production with that in older fields.

### Springwells Station

Wm. C. Rudd, asst. engr. in charge of power, and B. J. Mulligan, chief plant engineer, presented a combined paper on the new Springwells Station, followed by an inspection trip. Design details with which the first part of the paper dealt have appeared in *Power* (Mar. 24, 1931, pp. 468–71, and Sept., 1933, p. 470). Design complications resulting from plant location with respect to the distribution system and its fluctuating water flow, as well as economy of operation, dictated the selection of motor-driven centrifugal pumps with combinations of constant-speed and adjustable-speed motors of various sizes. Steam-turbine drives through helical-reduction gears, variable-capacity electric drives with either slip-ring motors or a combination of constant- and variable-speed motors, and constant-speed electric drive with either synchronous or squirrel-cage motors were the five types considered. Preliminary studies showed turbine drives most expensive, both in investment and in fuel, maintenance and labor costs, with equal reliability, and that necessary capacity and head regulation could be obtained with one or two variable-speed slip-ring motors in the low-lift (from river to plant) and high-lift (distribution) services.

A 350-lb., 715-F, generating plant was built to secure continuous power supply, with a 5,000-kw. tie-in for throw-over. This plant now includes two 5,000-kw. main and three 500-kw. auxiliary turbines to permit maximum pumpage of 275 m.g.d There are also two 90,000-lb. per-hr. boilers. The ultimate plant will include two more 5,000-kw. turbines and one 500-kw. with two additional boilers, giving total maximum pumpage of 550 m.g.d.

Equipment was contracted for to the lowest responsible bidder, based on evaluated costs including initial and operating costs (20 yr.), with the understanding that field tests were to be made on all units and bonuses or penalties awarded accordingly. Pump manufacturers also had to provide models for preliminary test, largely because none possessed facilities for testing such large pumps in their own shops. Results on the full-size units very closely approximated those on the models, variations ranging to a maximum of 3%. One low-lift pump exceeded its guarantee, two fell below, to result in a $560 net penalty. Four out of five high-lift pumps exceeded their guarantees, resulting in a $977 bonus. The general conclusion is that model pump tests are of advantage to both supplier and purchaser, while field tests are beneficial principally to the purchaser.

### Turbo-Generators

Turbo-generators were similarly tested and resulted in a bonus of $7,885 to the supplier on a basis of $20 per lb. of weighted steam flow per hr. Turbines were not in a factory-clean condition when tested, which affected results somewhat. Boilers had been in operation about 17 mo. when tested. They showed $Co_2$ of 12.7 and 13.85%, and over-all efficiencies ranging from 84.3 to 87.25%.

Operating results indicate that 1,000,000 gal. of water can be delivered with 190 kwhr. input to low-lift pump motors, 486 to the high-lift intermediate system, and 735 to the high-lift, high-service system. Average power demand is 4100 kw., with a peak of 10,350 kw., with turbo-generator load factor 69%, capacity factor 24%, and power purchased from standby 3.21%. Maximum load carried by any boiler was at a rating of 323%. Though design calls for 700-F steam, average steam temperature is about 670 F. Air heaters have such small apertures for gas passage that,

even with superheated-steam sootblowing, some trouble has been experienced with filling of apertures with slightly caked soot or fly ash. No air or gas bypasses have been provided, a possible cause of forced shutdown.

Boiler efficiency checks within 2% of test results, and the Apexiored interiors have shown no traces of scaling and very minor pitting in two years of operation.

Over-all station economy figures for last year are: Thermal efficiency of pumping plant, 16.06%; fuel rate, 1.136 lb. dry coal per net guaranteed kwhr. Av. equiv. evap. 12.35 lb. of steam per lb. dry coal from and at 212 F. Av. plant water rate 11.91 lb. steam per net kwhr. Electric rate per whphr is 0.927 kwhr. Coal required to pump 1,000,000 gal. 100 ft. high for Springwells is 479 lb. Average cost of pumping water is $6.62 per 1,000,000 gal., as compared with $8.13 for the older Water Works Park Station. Purification at Springwells costs $2.52 per mg, at Water Works Park, $2.98.

In discussion, George H. Fenkell, general manager of the plant, pointed out the importance of planned design and operation. He said that the site had been secured before engineering began, that the staff was secured through civil service examinations in 40 cities, that engineering work was begun early in planning, that architects were familiar with design for engineering, that contracts included arbitration provisions, that bids were evaluated—not simply accepted as offered, that consulting engineers were hired as circumstances justified, that Detroit Edison's engineering staff helped, and that Alex Dow of Detroit Edison acted as the engineer member of the Board of Water Works.

A Worthington representative pointed out the closeness of the model and full-size comparisons, and the importance of testing a model with conditions exactly like those to be encountered in service, because any small variation is magnified in the final unit. He also felt that two models might be advisable, one 50% larger than the other, for checking purposes. A General Electric representative pointed out that turbines at time of test were dirty and rust pitted, and could not be cleaned entirely. The first turbine tested was cleaned out with kerosene, the second with fly ash, with better results.

### Cinders and Fly Ash

Arthur C. Stern, engineer of the Air Pollution Survey, New York City Health Dept., discussed "The Separation and Emission of Cinders in Fly Ash," in which he gave size-frequency analysis of cinders and fly ash, and variation in the efficiency of dust separation with varying dust-particle size. These two factors may be combined to determine the over-all efficiency of separation. He also outlined rational methods for calculation of dust separation and emission in complex fuel-burning units. He pointed out what experimental data must be made available to designers before they may fully utilize any method of predetermining the operating characteristics of equipment with respect to cinder and fly ash emission, and attempted a theoretical analysis of the efficiency of dust separation in settling chambers, centrifugal concentrators and cyclone separators.

### Incinerators

H. S. Hersey, vice-president and general manager, C. O. Bartlett & Snow Co., discussed "Incinerators—Municipal, Industrial and Domestic." Although he mentioned industrial waste incineration briefly, and discussed incineration of domestic and institutional waste in some detail, the greater part of his paper is devoted to incineration of municipal waste. He pointed out that industrial incinerators require individual study, as, for example, when material to be burned is highly inflammable like photographic film waste, with likelihood of explosions and the necessity of recovering silver salts from the ash. In some installations there is also the problem of burning miscellaneous factory waste. Such incinerators require large combustion chambers, with a free opening beyond the primary fire and negative pressure so that ample air will be brought in to maintain an oxidizing condition for deodorizing. With highly combustible and light-weight material, difficulty is experienced in trapping the ash, even with combustion chambers of relatively large volume, and it may be found necessary to use water-spray or wet-type dust collectors. One interesting industrial incinerator has waste-heat boilers for burning materials with a heating value up to 16,000 B.t.u. per lb., between 3 and 4 lb. of process steam being produced per pound of refuse burned at rates ranging from 16,000 to 22,000 lb. per hr. The waste-heat plant operates 24 hr. per day, but steam production is only possible for three periods of about 6 hr. each, as required fire cleaning takes 2 hr. three times a day.

### Steam for Incinerators

The author explained that most American incinerator plants make no use of waste heat, although English and Continental plants do. Some American plants, however, apply waste-heat steam for servicing municipally owned asphalt plants, others sell steam or power in quantity to public utilities, while still others use steam for operating equipment or auxiliaries to the incinerator; often in the latter case, however, it is cheaper to buy the power than to produce it. Probably the outstanding installation making profitable use of steam is the rubbish-burning incinerator plant at Rochester, N. Y. This incinerator is next to the garbage reduction plant, which requires large quantities of steam. Rochester Gas & Electric Corp., also can supply steam in excess of that produced by the incinerator plant when requested. A new incinerator plant is soon to be built, which may supply sufficient extra steam so that no steam need be purchased.

Mr. Hersey pointed out that difficulty in the design of steam-producing incinerator plants includes the problem of a variable fuel, often extremely wet, so that the designer must plan for both very high and very low conditions. Also steam demand may fluctuate widely, not in coincidence with available material for incineration, thus over-all efficiency of boiler furnace and grate may vary from a low of 25% to a high of about 65%, but should not be less than 50%. English practice indicates plant evaporation on the from-and-at basis from 0.8 to 3 lb. of steam per lb. of refuse burned. Paris, France, gets about 1.1 lb. of steam per lb. of refuse. American records indicate evaporations from 0.7 to 1.5 lb.

At the second general session, Charles F. Kettering, vice-president of General Motors, substituted for W. S. Knudsen, president of the company, for the first paper. Mr. Kettering pointed out that knowing the indications of a business cycle does no good, because business cycles occur anyhow. He feels that research is an insurance against business variations, and therefore cannot be considered in the same light as normal operating expenses. He also explained that between development of a new product and its acceptance by the field is a period in which the product is earning nothing, which he characterizes as the "shirt-losing zone." He also indicated the importance of "intelligent ignorance" in considering new developments.

### Condensers

The next afternoon two papers were presented at a condenser session, "The Prevention of Failures of Surface-Condenser Tubes," by Robert E. Dillon, superintendent of the generating department, and George C. Eaton, head of the mechanical, Technical Engineering Division, Generating Department, Edison Electric Illuminating Co. of Boston, and H. Peters, assistant professor of aeronautical engineering, M.I.T., and "Condensation of Flowing Steam (Part I—Condensation and Diverging Nozzles," by J. I. Yellott of Stevens Institute, and C. K. Holland, of Phoenix Engineering Corp. In reading the first paper, Mr. Eaton described developments in prevention of failure of surface-condenser tubes by Edison Electric Illuminating Co., and applied latest theories of destructive cavitation to show that inlet-end wastage of tubes in a single-pass condenser is the result of vortices in the inlet water box. These vortices resulted in destructive cavitation which starts when water pressure at a point approaches the pressure corresponding to water temperature and cavities in the water are filled with vapor. When the existence condition for the vapor disappears through increase of pressure, vapor bubbles condense and very high impact on adjacent surfaces results. Tiny particles are broken from the surface by repeated impacts, making larger pits, and eventually holes are produced through the tubes. Guide vanes installed in the inlet water box of the

condenser have effectively prevented vertices from forming.

In discussion it was brought out that inserts in tubes must be ringed internally to knife edges on the downstream side to decrease turbulence, and that bitumastic or other paints will increase tube life, particularly on tubes beginning to corrode through. M. H. Curley, of Long Island Lighting, explained that they retube 2-pass condensers every three years, and the last year of the three use inserts in tube ends similar to those described by the authors. The first week in May they shut down one condenser, due to salt water, and found two tubes failed, due to inlet-end corrosion and erosion, beginning ½-in. from one end and extending 1-in. This occurs at the lower end of the first pass and the upper end of the second. Points near the outside are unaffected. Inserts are attacked at the same rate as the original tube, and must be fastened with cement or will become loose.

### Air and Oxygen

James T. Kemp, of American Brass Co., pointed out that air and dissolved oxygen are corrosive factors and that pebbles and other small pieces of foreign matter in a tube permit erosion in their "shadows." In conclusion, the authors brought out that the process of tube making apparently has no effect, that service conditions are of much more importance. V. M. Frost, of New Jersey Public Service, mentioned that the paper should have brought out data on discharge also, and that the outlet side of the condenser should be submerged always to help in keeping air out of the condenser. The authors pointed out also that it is possible to tell whether corrosion or cavitation is the factor causing the difficulty, provided only one is present. It is important that cooling water flow quietly and smoothly with no sharp bends, even if design is modified.

Professor Yellott presented the second paper, showing apparatus and methods used to determine the condensation point in nozzles with very short throat and angles of divergence greater than 2 deg. Highly technical, the paper included several interesting charts and a number of color photographs showing flow through the nozzle at varying pressures and nozzle conditions.

### Forced-Draft Spreader Stoker

J. F. Barkley, supervising engineer, U. S. Bureau of Mines, presented "The Forced-Draft Spreader Stoker," in which he gave reasons for adoption of spreader stokers in government plants, and discussed the adaptability of the types used in different installations for various grades of fuel. By forced-draft spreader stoker he means forced-draft fuel-burning equipment in which the fuel is spread or thrown into a combustion space, part of the fuel burning in suspension and part dropping onto a high-resistant type grate, in which burning is completed. With increasing application of this type of stoker, air zoning came into use and preheated air was successfuly applied. Grate areas were usually made liberal for small boilers, extending across the width from about 6 to 8 ft. deep, where ash was pulled out by hand. Where loads were unexpectedly low it was occasionally found advantageous to brick off some of the grate area. In large boilers, depth of spread of about 12 ft. has been used. Higher burning rates and temperature brought clinkering difficulties which in some cases were solved by more frequent dumping, in others by air-coiled Carborundum brick along the grate line. Larger boiler installations running at high ratings are now equipped with water-cooled furnaces. The spreader stoker is very sensitive to regulation in regard to smoke emission, a slight turn of the hand giving too much fuel feed for the air, immediately causing excessive smoke. Vertically baffled boilers usually do not provide the length of flame travel or the same kind of mixing provided by long horizontal combustion chambers in h.r.t. boilers, and high load-carrying capacity of the stoker tempted firemen to carry high loads and use fewer boilers than planned. Anthracite and semi-anthracite coals give no trouble from smoke, but all bituminous and low-rank coals may do so. For these coals, Mr. Barkley suggests flame travel of at least 14 ft., and such travel horizontally across the grate, if possible.

Heat releases of 20,000 to 35,000 B.t.u. per hr. per cu. ft. of furnace volume usually are used. A heat release of over 100,000 B.t.u. was obtained on one test, but made much smoke. Furnace temperatures should ordinarily be under 2,400 F. Furnace temperature has a bearing on the possibilities of boiler-tube slagging.

With poor furnace conditions, smoke emission can be reduced with steam or air jets crossfiring from the front of the setting and aimed somewhat downward, toward the rear of the grate.

Fly-ash problems also came to the front with this stoker. Throwing fine coal up into space to be burned gives fine ash particles a good start on the flight with the products of combustion. With vertical baffles, fly ash that with horizontal baffles would drop behind the bridge wall went on into the boiler passes. The amount of fly ash depends not only on load and total amount of ash, but also on type of coal, although anthracite and semi-bituminous coals give more ash carryover than some lower rank coals having some 10% inherent moisture, it cannot always be judged exactly what relative carryover may be expected from some particular coal. Where there is excessive fly ash, collecting-hopper arrangements may be provided in back chambers and passes in the boiler. Some well-designed installations provide an ejector that returns fly ash from a boiler pass to the combustion chamber, or simple baffle-type cinder catchers may be installed in breechings, but must be dumped regularly.

In general, spreader stokers show on test about the same over-all boiler efficiency as underfeed stokers, except for carbon loss and fly ash. On installations

**Fig. 1—Water and steam diagram for Southern Alkali Corp., 500-kw. power plant**

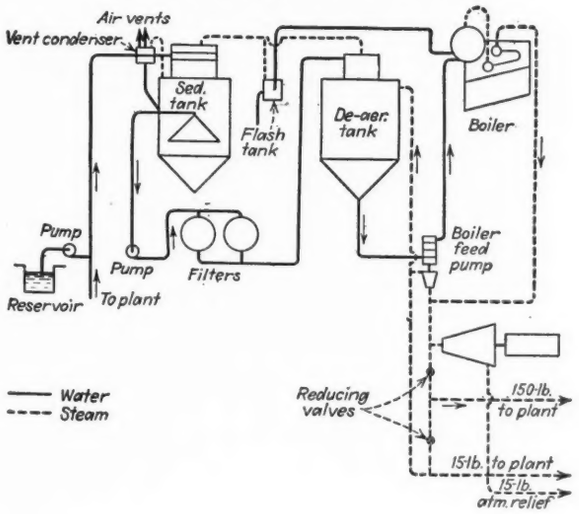
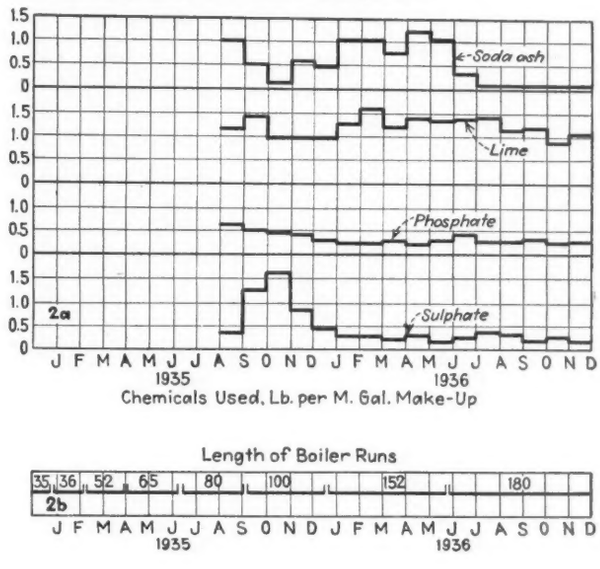



**Fig. 2a—Chemicals used per 1000 gal. of make-up water, Southern Alkali Corp. Fig. 2b—With better treatment of feedwater, boilers stay in operation for longer periods**


Soda ash
Lime
Phosphate
Sulphate
2a
J F M A M J J A S O N D J F M A M J J A S O N D
1935
1936
Chemicals Used, Lb. per M. Gal. Make-Up
Length of Boiler Runs
35 36 52 65 80 100 152 180
2b
J F M A M J J A S O N D J F M A M J J A S O N D
1935
1936

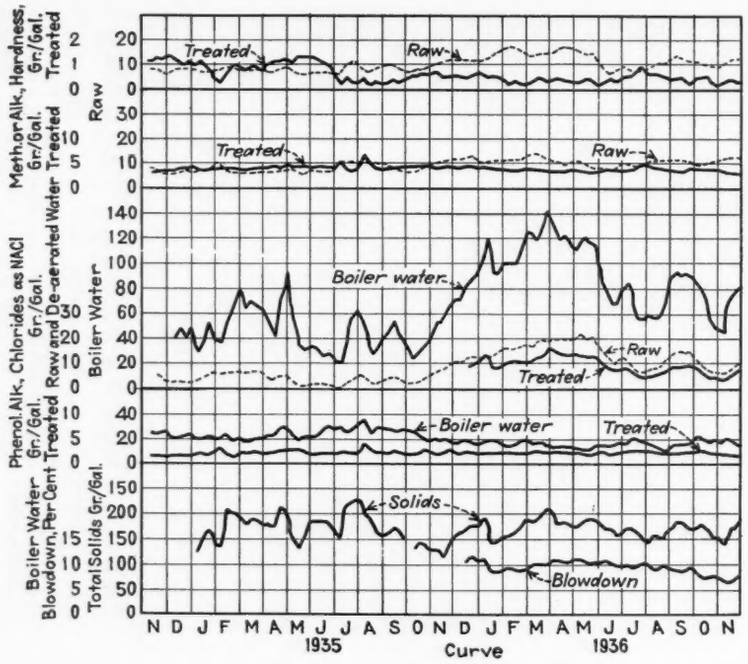



**Fig. 3—Results of water tests, Southern Alkali Corp.**

that provide for burning out carbon, such differences practically disappear. On poorer coals, the spread stoker has a distinct advantage.

The same afternoon the special research committee on lubrication sponsored two papers of a highly technical nature. The first, "Boundary Lubrication Studies—I, The Variables Influencing Static Friction Measurements Between Dry and Lubricated Metal Surfaces," was presented by W. E. Campbell, of Bell Telephone Laboratories. The second, "Oil Film Thickness at Transition from Semi-Fluid to Viscous Lubrication," was presented by G. B. Karelitz and J. N. Kenyon, of Columbia University. The tests of these latter two authors indicated that film thicknesses are substantially independent of load for an individual material.

### Pooling Power

J. E. Parker and R. E. Greene, of Detroit Edison Co., presented "Pooling Power in a Large Industrial Center." This paper deals largely with the application of a large connected system, such as that of Detroit Edison Co., in providing reserve capacity to meet exigencies of operation and excess capacities to meet unpredicted and sudden demands for power without undue cost. The authors pointed out the Detroit system is unusual in that it is somewhat isolated, having few tie-ins. Residential and commercial loads are pretty stable, but industrial load fluctuates violently. In the area, 22 major turbines are available, mostly 50,000-kw. units, although there are two 60,000- and a 75,000-kw. unit coming. Scheduling is vitally important because it requires 60 and 90 days for overhaul once in three years per machine, therefore one machine at least must be in reserve continually. Present practice is to provide a total reserve of 120,000 kw., about 16% of total generator capacity.

The authors pointed out that as a result of standardization for a number of years on 50,000-kw. units the six machines of Trenton Channel have a spare rotor which can be used on any machine. Actually, this "spare" has been in use 50% of its life thus far, and if necessary a changeover from one rotor to another can be made in 48 hr. Detroit Edison at present is not much interested in machines over 75,000 kw. They prefer small units so that not too much capacity is lost when a turbine goes out. They also do not want the single plant to become too big; 300,000 to 400,000 kw. is the present desired maximum.

Mr. Parker pointed out also that a utility must be prepared to take blast furnace gas or other by-product from industry in exchange for power, and that "reactive" and "flywheel" are two of the things which are most important in what the utility has for sale.

Mr. Greene described the Detroit "loose link" system in detail, showing how Detroit is divided into five power areas, with each virtually having its own plant. the areas being tied together with relatively small ties, and area boundaries being shifted to meet existing conditions a number of times each day. The system is called upon only in major failures.

In discussion, William Munro, Sargent & Lundy, said that the whole 650-lb. unit at State Line has never been off the line completely in 7½ years, although each element has been out for repair occasionally. Early in May the high-pressure turbine element kicked out, but the two low-pressure portions took the load without faltering. The first 1,250-lb. boiler has just gone into operation.

In closing, Mr. Parker said that changes in condenser practice effected changes in Connors Creek Station. As a result of modern design they can now put a 60,000-kw. turbine on a 30,000-kw. condenser, and a 30,000-kw. turbine on a 20,000-kw. condenser, providing good or better efficiency and additional capacity. Detroit Edison did not feel at Connors Creek that reheat was justified in cost over the super-regenerative cycle. New additions to the plant are to be 900 deg., although Detroit Edison pioneered in 1,000-deg. experiments—"Perhaps for that reason", as Mr. Parker put it.

In answer to a question, Mr. Parker said that they have successfully picked up at Connors Creek load dropped at Marysville Station, at another extreme of the system.

### Operating Problems

G. R. Avery, Steam and Power Department Superintendent, Southern Alkali Corp., described operating experience with his plant, including two 12,000-sq. ft. boilers operating at 400 lb. and 600 F, two 2,500-kw. turbines, two main feedwater pumps, two booster pumps, two fresh-water pumps, and water-treating and proportioning equipment. Boilers are crossdrum units with sectional headers and above-deck desuperheaters, air-cooled walls, and no economizers or air preheaters. Turbines bleed at 150 lb. and exhaust at 15 lb. to process, Fig. 1.

Boiler water is heated to 230 F and treated by the hot lime-soda process in a sedimentation tank. Booster pumps carry it through filters to a deaeration tank; then it is heated to 250 F and pumped into the boilers by turbine-driven feed pumps controlled by a constant excess-pressure, diaphragm-operated regular on the steam line.

Disodium phosphate solutions (25-30 gal. anhydrous per 100 gal. $H_2O$) is pumped directly to boilers. The chemical solution of soda ash and lime, plus sodium phosphate when required, is kept in a proportioner supply tank, its level being controlled by mercoid switch to maintain constant ratio between chemical solution and phosphate added per gallon of makeup. Phosphate excess is usually 50 to 100 p.p.m.

Raw and treated water tests are made every 2 hr., boiler water tests every 3 hr., and boiler-water solids by hydrometer each hour. Results are shown in Fig. 3.

To check the effect of returning blowdown to the system, bimonthly analyses are made on raw, treated and boiler-water samples for insoluble silica, $Al_2O_3$, soluble silica pH of boil r water and steam. Condensate returned from the caustic-soda department is checked continuously with a conductivity meter to guard against high boiler-water alkalinity. Fig. 2a shows chemicals used per 1000 gal. of makeup, permitting computation of water-treatment costs.

At first, before treated water was clear, soft sludge and hard scale deposited on tubes, sludge analysis being:

$CO_2$ $(PO_4)_2$ 41.5% (by weight), $AlPO_4$ 28.1, $CaCO_3$ 4.6, $CaSO_4$ 2.8, $SiO_2$ 1.7, Fe 9.6, $Al_2O_3$, 11.7; scale analysis: $SiO_2$ 2.26%, $R_2O_3$ 91.75 (including metallic iron as well as oxide of iron and aluminum, $CaCO_3$ 4.12, $MgCO_3$ 1.68, $CaSO_4$ 4.40. Water had high turbidity and fairly low hardness and chloride content. Boilers could be operated only 35 to 50 days without cleaning. Coagulants in the sedimentation tank improved clarity. As hardness and chloride content of the raw water increased, treated water became clear, so no coagulants are now used. Periods of operation are now 180 days or more, Fig. 2b.

### Blowdown

During periods of low chloride concentration in the raw water, continuous blowdown is returned to the reservoir, building up the amounts of solid and chloride in the water. No trouble with turbidity occurs.

Operating the softener at too high a rate is not a factor in preventing cleaning of turbid water, because with normal 3 hr. 10 min. settling time, 43.7 gal. of water per sq. ft. of filter area are obtained, while with minimum settling time of 1 hr. 10 min., 83.5 gal. are obtained.

Boiler output ranges from 175% to 325% of rating, not excessive, and all conditions favor production of clean steam. Continuous blowdown is manually regulated, depending on boiler-water alkalinity or on total solids, governed by boiler load. Present blowdown is rather high, but justified by boiler water and tube conditions, low cost of water and fuel, and isolation of the plant.

Steam carryover into turbines is negligible, as are deposits on turbine blading. Solids were carried over at first when alkalinity was high to avoid sodium-aluminum-silicate deposits in boiler tubes. This had to be scraped and brushed off. Its analysis was (by weight): NaCl 61.10%, $Na_2SO_4$ 19.08 NaOH 0.40, $Na_2CO_3$ 8.79 (by difference), $CaSO_4$ 5.41, $MgSO_4$ 0.61, $SiO_2$ 3.49, $R_2O_3$ 0.58, moisture 0.54. Turbine blades have rusted and pitted somewhat, due possibly to steam leakage through shut-off valves, steam traps or atmospheric moisture. They plan to replace with stainless steel, or equivalent, when it becomes necessary. Vents have been arranged between valves on pressure lines to the turbine to avoid steam leakage, and turbine traps now discharge to atmosphere.

Along the Coast, moisture and high humidity provide ever-present problems. Electric heaters are installed in generators and motor bases, interlocked with the exciter switch to go on when it is open and vice versa. Megger readings used to show 150,000 ohms; with the heaters this has increased to 1 to 2,000,000 ohms. Motors and generators are also covered with canvas when not in use to protect against moisture.

Acid-resistant bronze is required for salt-water pumps, and monel impellers are to be put in fresh-water pumps.

Feedwater treatment is controlled with a proportioner unit so that water-condition changes are met by varying weights of chemicals per charge. Sedimentation-tank water pressure is controlled by pilot air-operated valves. Boiler control is air operated, an emergency steam-driven air compressor supplementing the plant air system. Fuel (natural gas) and air flow are controlled by air pressure from the master pressure controller and a separate adjustment for air control on the uptake damper. Main difficulties here have been with air leaks and in adjusting controls to the same lag as the controlled equipment. In case of power failure, d.c. solenoid-operated valves in the control line open the ID damper and close the fuel-regulating valves to a predetermined point, permitting temporary manual regulation.

E. O. Waters, F. S. G. Williams, D. B. Rossheim, and D. B. Wesstrom cooperated in a highly technical paper on "Formulas for Stresses in Bolted Flange Connections," which outlines a revised analysis based on the ring, tapered hub, and shell considered as three elastically coupled units loaded by a bolting moment, a hydrostatic pressure, or a combination of the two.

**At the dinner, Alex Dow looks on as Pres. Herron presents the Holley Medal to Henry Ford**

*Detroit Free Press*

### Dinner Meeting

The sixth general session was a dinner meeting including the talk by Pres. James H. Herron of the Society on the week's program and its implications, and an address by Col. Willard T. Chevalier, vice-president of the McGraw-Hill Publishing Co., Inc. Honorary membership was also conferred on Alex Dow, past president, and president of Detroit Edison Co., and the Holley Medal presented to Henry Ford. Mr. Herron pointed out that there are two classes of engineers, the creative and the practical, and that only rarely does one man possess both qualities, It is also important that engineers bear in mind the interdependence of the entire profession, in that all classes work together toward a common goal.

In presenting Henry Ford for the Holley Medal, Mr. Dow mentioned that the two of them long years ago worked together for Detroit Edison, and both had always wanted to know the "why" of everything. Said Mr. Dow: "Mr. Ford and I argued up and down as to what was proper pay for a working man. I argued dollars and cents. Mr. Ford said that proper pay was that which would permit a man to marry and bring up a family decently. That was in 1897, or thereabouts, but each of us, in our own way, has tried since that time to live up to that principle." The Holley Medal presented for some unique and outstanding accomplishment, was presented to Henry Ford for "revolutionary influence, through invention and practice, on transportation and on mass production methods." Honorary membership in the society was conferred upon Mr. Dow, Harvey N. Davis pointing out that Mr. Dow had had to do with engineering, technical achievements, money and men. particularly men, and that a man dealing with management has climbed to one of the pinnacles of engineering achievement.

In the address of the evening, Colonel Chevalier showed that everything that has happened in transportation for thousands of years has happened in the past 126 years, since the invention of the steamboat and the railroad, and that discovery of the expansive power of steam was the most significant step in the history of development of the world. Colonel Chevalier explained that ours is an economy of production and *exchange*, not distribution, because nobody is entitled to share in distribution who does not share in production. Colonel Chevalier also pointed out that money is nothing but a laundry check, and "no matter how many checks a Chinaman writes, they are worth only the number of shirts he has on the shelf."

The new officers, from left to right: William Culbert, president; W. E. E. Koepler, 1st vice-president; Frank A. Chambers, secretary-treasurer; J. M. Whalen, 2nd vice-president; and C. L. Goodman, sergeant-at-arms

# Smoke Prevention—1937

***Smoke Prevention Assn. meets in New York city for 31st Annual Convention; elects as president William Culbert, Chief Smoke Inspector of Nashville, Tenn.***

OVER 200 smoke inspectors, railroad and coal men, and power engineers attended the 31st Annual Convention of the Smoke Prevention Association, held in New York City's Hotel Pennsylvania, June 1-4. Elected as next year's officers of the organization were: president, William Culbert, chief smoke inspector of Nashville, Tenn.; 1st vice-president, W. E. E. Koepler (re-elected); 2nd vice-president, J. M. Whalen, master mechanic, Missouri Pacific Railroad; secretary-treasurer, Frank A. Chambers, chief smoke inspector of Chicago, Ill. (re-elected); and sergeant-at-arms, C. L. Goodman, roundhouse foreman, Chicago Short Line Railroad. The Association selected Nashville, Tenn., as its convention city for 1938.

The opening session on Tuesday, June 1, was occupied with business, welcome by city officials, and an inspection of the S. S. *Normandie*. Wednesday was denoted "Hudson County Day", and the convention moved over to Hoboken, N. J. (in Hudson County) for a 1-day session at the Stevens Institute of Technology. Following a greeting by Dr. Harvey N. Davis, president of Stevens, three papers were presented on railroad, marine, and industrial smoke prevention.

George H. Massey, master mechanic of the Central Railroad of N. J.; M. J. Hanlon, vice-president of the Black Diamond Steamship Corp.; and A. W. Akins of the Standard Oil Co. of N. J. told the meeting what their respective fields had done towards smoke abatement in Hudson County. Their opinions were corroborated by John L. Hodges, deputy smoke abatement engineer of Hudson County, who described the remarkable strides made in recent years in smoke abatement.

Prof. H. C. Frank, Physics Dept., Stevens Institute of Technology, described the method of detecting sources of air pollution which has been developed in the past 6½ years. At present there are three stations, two in New York City at Central Park and the downtown Whitehall Building, and one in Hoboken at Stevens. By taking readings on Owens machines at these three stations and plotting the product of smoke density and wind velocity for the eight major points of the compass, so-called "roses" (the flower-like figures produced by connecting the eight plotted points) are determined for each station. Then by triangulation, extending lines along the long axis of each "rose", the source of air pollution is indicated.

### Washington, D. C.

The opening paper on Thursday was presented by H. K. Kugel, smoke regulation engineer, Washington, D. C., who spoke on experiences with Washington's new smoke ordinance. Briefly, the ordinance states that any emission of No. 3 Ringelman smoke or above constitutes a violation. Mr. Kugel remarked that 73% of violations are caused by hand-fired boilers and that there is a decided need for better incinerators.

Railroad smoke abatement came in for more scrutiny when C. B. Keiser, assistant to general supt. of motor power, Pennsylvania Railroad, described use of low-volatile coals for switching engines, improved firing methods on long-haul locomotives and training of firemen. "Smoke Prevention in Air Conditioning", by G. W. Penney, manager, Electro-Physics Div., Westinghouse Electric & Mfg. Co., consisted mainly of a description of the Westinghouse electrostatic precipitator, in which polluted air is first passed over an ionizing wire, then past charged baffle plates on which the foreign particles are precipitated.

A. C. Stern of New York City reported on the WPA air-pollution survey being made with the cooperation of the New York City Health Dept. The survey is not complete, but information has been gathered showing New York City's fuel consumption—where, what and how used. The complete report will show how much of air pollution is due to different types of fuels.

J. F. Barkeley, U. S. Bureau of Mines, Washington, D. C., described the federal central-heating plant in the nation's capital, and the equipment used to prevent smoke and fly ash. Economic conditions specified coal as the fuel, so the plant was designated with underfeed stokers to raise coal temperature gradually and cause less smoke. Other smoke-reducing factors: oversize grate areas, training periods for operators, cinder catchers, and Cottrell precipitator.

Two other papers presented on Thursday were, "Where Did the Smoke Go?", by C. A. Reed, combustion engineer, National Coal Assn., and "Five Years Dormancy in Smoke Prevention at Detroit," by C. J. McCabe, chief smoke inspector of Detroit, Mich.

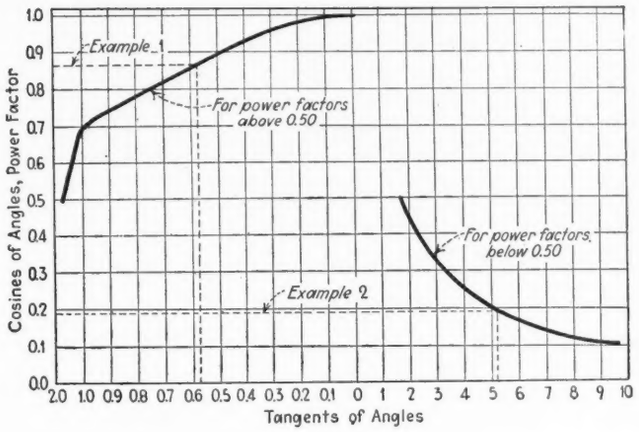
At the final session on Friday morning, D. C. Weeks, station efficiency engineer, Hudson Ave. Generating Station, Consolidated Edison Co. of N. Y., presented "Smoke Prevention and Elimination of Dust from Stacks of Generating Stations." Mr. Weeks explained careful selection of coal, high furnace settings, constant improvement of stokers, cinder catchers, over-fire air, and rotation of banking.

Mr. Week's final point was that generating stations should have built a number of small stacks instead of a small number of large ones, as the same volume of smoke from three or four small stacks will appear less dense than from a single large stack. A heated discussion took place over this statement, centering on the fact that velocity had not been taken into account, but finally all agreed that such an optical illusion might take place.

The final papers were "Locomotive Smoke Abatement", by E. E. Ramey, fuel engineer, B & O Railroad, and "Report on Recent Survey in Chicago of Air Pollution from Sulphur Gas", by A. D. Singh, University of Illinois.

William G. Christy (left), smoke abatement engineer of Hudson County, N. J., talks over the WPA New York City air pollution survey with A. C. Stern of the New York City Health Dept. (center) and H. K. Kugel (right), smoke regulation engineer of Washington, D. C.

# PRACTICAL AIDS TO OPERATION




## Chart for Determining Power Factor

When power of a balanced 3-phase circuit is measured by two wattmeters, it is possible to calculate the power factor directly from meter readings. Both meters indicate in the same direction when the power factor is above 0.50, and when the power factor is less than 0.50, one meter gives a negative reading. The accompanying chart was devised to simplify working out these problems.

To illustrate the use of the chart, assume that meter $W_1$ reads 400 kw. and meter $W_2$, 200 kw., both readings being positive. First find the tangent of the phase angle between the current and voltage. Tangent of angle $= 1.732 \times \frac{W_1 - W_2}{W_1 + W_2} = 1.732 \times \frac{400 - 200}{400 + 200} =$ 0.577. To obtain the power factor, locate tangent 0.577 along the bottom of the chart above, then run vertically upward to intersect the curve. Extend this intersection horizontally to the left-hand scale and read the power factor 0.87, as indicated by the dotted lines.

Assume that the high-reading meter indicates 400 kw. load and the low reading meter a negative reading of 200 kw. Then tangent of angle $= 1.732 \times \frac{400 - (-200)}{400 + (-200)} = 1.732 + \frac{400 + 200}{400 - 200} = 5.196$. On the chart locate tangent 5.196 and extend vertically to the curve, then to the right and read power factor 0.19.

*Nipigon, Ont.* H. E. Stafford

## How to Remove Gaskets From Close Joints

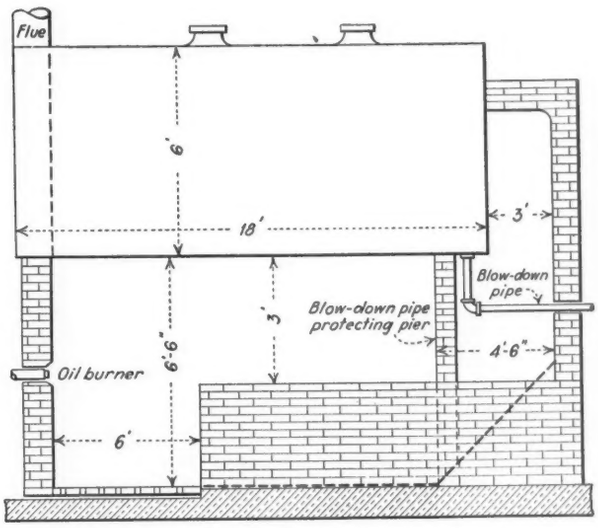
Occasionally a gasket leaks in a flange-joint which is so firmly anchored on a pipe that flanges cannot be pried apart to permit removal of the old gasket. In such cases, the gasket can be cut with an old hand saw after flange bolts have been removed. Whenever possible, flanges should be forced apart and scraped clear with a chisel. When this cannot be done, the saw may be used as a scraping tool. Bolts should all be given approximately equal tension in tightening, otherwise the joint may leak or the gasket fail.

*Omaha, Neb.* Emil J. Novak

## Insufficient Furnace Volume Caused Brick-Work Failure

Modern trends in reducing steam costs show a marked tendency towards more up-to-date combustion equipment. Often, this means changing from a hand-fired coal to an oil-burning installation. Expert consulting engineering services are usually engaged to design this change with large installations, but, unfortunately, less attention is given this problem in smaller boiler plants.

The diagram shows a horizontal-tubular boiler, after operating for some years with hand firing, which was changed over for oil burning. Lack of head room made it impracticable to provide greater furnace volume by raising the boiler, but it was possible to drop the furnace bottom down 6.5 ft. from the bottom of the boiler. The bridge wall was retained, as was the high floor section behind it, a construction that gave a furnace volume of 477 cu.ft. and made necessary a heat liberation of approximately 32,000 B.t.u. per cu.ft. per hr. when burning 100 gal. of oil per hr. as required at maximum boiler load. The unit heat release per hr. for all refractory furnaces, as recommended by most authorities, is 20,000 to 30,000 B.t.u. per cu.ft., the lower value being preferred for low furnaces.



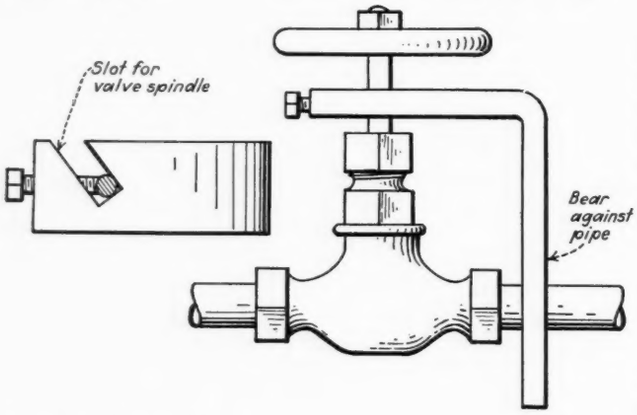

The furnace lining was not renewed when oil burners were installed, as it had been constructed of high grade firebrick several years previously and was still in good condition. After about three months' operation with oil, furnace linings pulled loose from the side-wall headers and collapsed. A number of headers pulled loose from side walls and supporting walls were damaged by exposure to furnace temperatures. Failure of walls in this manner is often caused by a volume change in the brick due to heating.

After plans were completed for repairing damaged walls and relining the furnace with firebrick, attention was given to preventing a repetition of this trouble. This was done by lowering the bridge wall and floor behind it to the same level as the furnace floor, as shown by the dotted line in the figure, giving a combustion-chamber

height of 6.5 ft. Rear of the combustion chamber floor was built up in a triangular section, to eliminate a dead gas corner. An added advantage of this slope is reflection of radiant heat onto the gas passage and onto rear boiler-heating surfaces.

The new furnace has a volume of 699 cu.ft., and when burning 100 gal. of oil per hr. has a heat release of 21,300 B.t.u. per hr. per cu.ft. with an increase in efficiency. A greater area of furnace-wall lining is exposed to radiant heat of the fire, which reduces the refractory heat absorption per unit of area necessary to maintain thermal balance in the brick.

*Boston, Mass.* C. O. DIBBLE




## An Easily Made Valve Lock

WHEN REPAIRS are being made on a line, it is advisable to lock the valve closed. A simple and effective type of lock that I use can be made from a piece of strap iron, see accompanying diagram. It is bent at right angles and a slot cut for the valve stem. The strap is slipped on the stem when the valve is closed, and then tightened in place with a setscrew when the strap bears against the pipe so that the valve cannot be opened.

*Hamilton, Ont.* H. MOORE

## A Temporary Connection Boner

RECENTLY at an eastern industrial plant, it became necessary to kill the 2,300- to 440-volt transformers supplying power-plant auxiliaries. To supply temporary power, primaries of spare transformers were tied into the lead of an idle generator and their secondaries connected to the 440-volt auxiliary bus through a spare switch, as in the figure. Since the two transformer banks could not be paralleled because of their different characteristics, it was decided to open quickly switch *A* on the regular transformers and then close *B* on the temporary ones. As only a matter of seconds would elapse while the station would be without auxiliary power, it was believed that draft fans, pulverizers and other auxiliary equipment would not slow down sufficiently to cause trouble.

Spare transformers were phased out, men stationed at the various switches and starting buttons, and on signal, the change-over was made. It was done so quickly that auxiliaries scarcely missed a beat. Then, the fireman shifted the induced-draft fan from low to high speed and the main generator breaker tripped out and dumped the entire load.

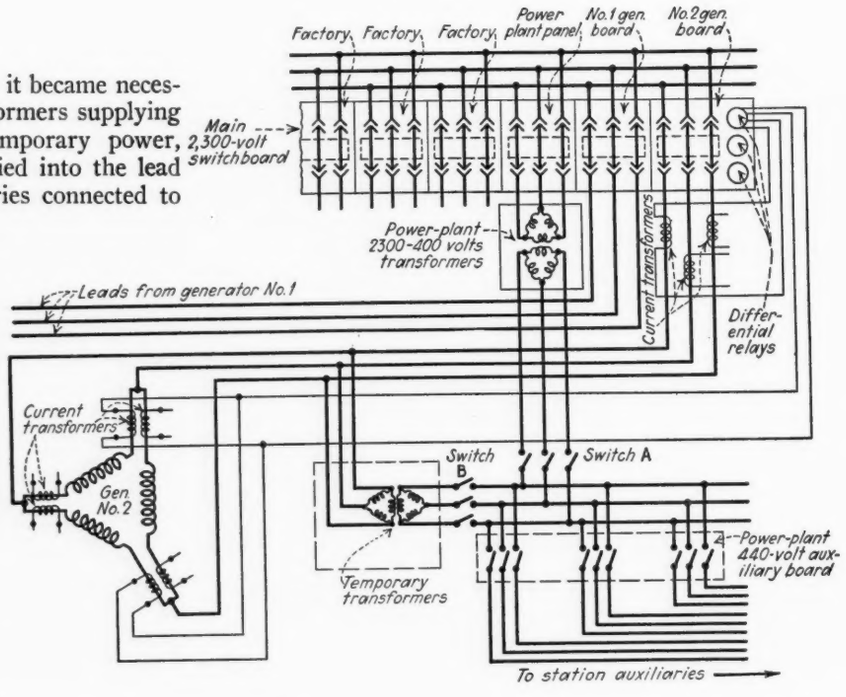
The switch on the temporary transformers was then opened, regular transformers were again connected into service, the main breaker closed, and auxiliaries started. The cause of the trouble was not hard to find. The temporary transformer primaries had been connected into the generator leads at a point between the current transformers at the generator and those on the main switchboard, which together operate the differential relays. These relays were set to trip out at 10% differential.

When the change-over was made, auxiliary load was less than 10% of the total and did not operate the differential relays. When the 45-hp. to 125-hp. motor of the induced-draft fan was put into high speed, unbalance became sufficient to make the differential relays function and trip the generator switch. This experience is submitted, not with pride, but rather with humiliation and in the hope that it may prevent others from making a similar mistake.

*New York, N. Y.* JOSEPH GISH

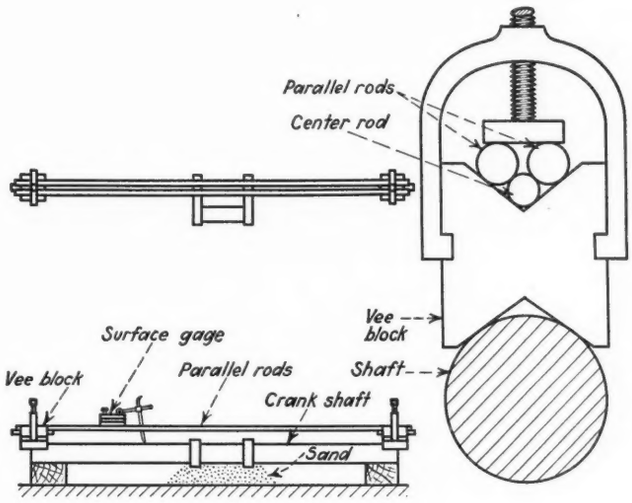
## Straightening a Crankshaft

A CRANKSHAFT, badly bent near the middle, was brought into the shop to be straightened. Efforts with leverage and a sledge hammer proved futile, so we decided to heat the shaft to a cherry red. The cement floor was the only solid surface large enough to accommodate the shaft, but was also an impossible surface from which to test trueness, so two clamp vees, two long straight rods and two short pieces were used to improvise a surface. The short pieces were placed in the bottom of the vees and the long rods, cut to leave a space between them when they were tightened up by clamp screws, were laid on top, one at each side. With shaft ends



placed on blocks and the crankpin supported on a pile of packed sand, the shaft was hammered straight. Tests were made from time to time by placing the vee block-rod arrangement on top of the shaft and running a scriber between the rods, as in the figure.

Sand was placed under the crankpin to support it and




was not as difficult to do as it may seem. I put pieces of copper on the shaft for sledge-hammer striking pads, but, of course, there were a few dents to smooth out when the job was finished. Perhaps I was lucky, but the shaft was straightened with a few blows of the sledge after hours were wasted trying other methods.

*Hamilton, Ont.* H. MOORE

## Preventing Flare-back On Low Ratings

WE FOUND it impossible to keep a steady flame in the furnaces of our pulverized-coal fired boilers at the low ratings encountered on our night runs. Faulty control of air pressure in the pulverizer was finally discovered to be the basic trouble. At light loads, the correct setting is for less than atmospheric pressure, the exact amount to be determined by trial. With a positive air pressure in the pulverizer and rate of coal feed reduced to keep steam pressure within control of the coal-air damper, fire died out from too lean a mixture. Also, with too much suction in the pulverizer, there was apparently such a vacuum formed that the blower could not pick up coal particles, and the fire again went out.

Our mills are 3,000-lb. per hr., hammer-type, 1,700-r.p.m. units with performance guarantees based on 13,000-B.t.u. bituminous screenings. The 4-drum, bent-tube boiler operates at 285 lb. pressure, 300 F superheat at full load, and approximately 375 F pre-heated air. The boiler is a special type, fired either from the front with hog fuel in a dutch oven, or from the rear with pulverized coal from two mills. Specifications call for a minimum rating of 12,000 lb. of steam per hr. and a maximum of 27,500 lb. We had no trouble in maintaining the maximum, but were unable to get below 18,000 lb.

The original installation had 10-in. burners which produced a long flame that sometimes extended into the dutch oven, and at light loads either the flame burnt in the front end or else went out completely. The pulverizer company's engineer suggested replacing the 10-in. with 12-in. burners to reduce entrance velocity, and thus possibly produce a short bushy flame. This change made it possible to get down to 14,000 lb. with a good flame, but still lower ratings were necessary. Distributing cones were next installed to remove coal streamers. These made possible increased efficiencies but did not lower rating.

By increasing draft to 0.15 in., we obtained steady operation at light load, but since this gave decreased efficiency, we kept on searching for the real trouble. With as rich a coal mixture as is possible to control, and very careful regulation of air pressure in the pulverizer, we were able to get down to 6,000 lb. per hr. with guaranteed efficiency.

Preheated air is, of course, necessary for most successful operation. To supply air when the master controller shuts off the fan as pressure rises above operating conditions, it was necessary to block the fan slightly open—shutting air off made the flame die out.

*Bemidji, Minn.* S. F. DES MARAIS

## Ball Bearings Cleaned in Washing Machine

A MOTOR-OPERATED washing machine in which anti-friction bearings are thoroughly washed and scrubbed has proved a great aid in servicing motors at our Chicago shop. Two baskets about 10 x 15 in. and 5 in. high, shown in the photo, are suspended from a motor-and-gear driven rocker arm that dips the baskets in and out of the cleaning fluid 44 times a minute. All bearings are washed for at least 30 min.

When a bearing comes out of this machine every particle of hard grease and dirt has been removed. It is then coated with fresh lubricant and wrapped in oil-proof paper for storage until re-assembled in the motor.

J. W. GREVE
*Westinghouse Elec. & Mfg. Co.*
*East Pittsburgh, Pa.*

# CURRENT COMMENT

## Fifteen Causes of Short Belt Life

I HAVE read with interest the discussions on causes of short belt life. From my experience, short belt life results from a number of causes, such as:

Pulley not in proper alignment.

Overloading.

Insufficient or too much tension.

Unfavorable atmospheric condition, such as too hot, too dry or too much moisture.

Pulley too small for belt thickness.

Poorly aligned belt tightener.

Frequent use of and poorly aligned belt shifters.

Oil and dust accumulations on belts.

Resinous dressings that build up accumulations on belts and pulleys.

Excessive belt speed.

Belt of materials and construction not suited to the application.

Too small arc of contact with a small pulley.

Unsuitable fasteners.

Short-center crossed and quarter-turn belts usually have a shorter life than open belts operating under similar conditions. Belts that are too loose will slip and wear rapidly and if too tight they may break or split, and in any event will have a short life.

*Lexington, Ky.* I. A. BUTCHER

## Comparing Generated And Purchased Energy

ATTENTION should be called to some fallacies in "How to Compare Generated and Purchased Power Costs—I," May *Power*, which this article has in common with most other articles that have been published on this subject.

First of all, an engineer experienced in making these cost comparisons knows that each case must be considered on its own merits, for rarely are there two similar cases. In each individual case he will find no difficulty in setting up a proper cost comparison, if power cost alone is considered. On the other hand, no book or article will give much aid to an inexperienced person. Any attempt to apply to one condition a formula that was developed for some other definite condition will often result in overlooking important factors.

One difficult problem is evaluating relative reliability of the service. An isolated plant with two or more good units and competent operation may be more dependable than power purchased at the end of a single power circuit. Yet two isolated power houses may be less reliable than a supply from an important inter-connected system. What are the relative probabilities of interruptions and their duration and what will such interruptions mean to the manufacturing process? These are questions of great importance to the factory, yet frequently they are not considered.

Before the question of generation versus purchase can be approached, the engineer should acquire a thorough familiarity with the production process. Nor should he forget that long after the engineer who designed the power system has left the premises and forgotten all about it, the factory owner and manager will still have to live with it.

Many factors not exactly related to economy must be considered, as for instance, additional responsibility and burden that operation of a power house will place on a management that may be already overburdened with responsibilities. And it is utterly insufficient to consider only present conditions. Not only must possible future growth be considered, but also various factors that may in the future change the cost comparison. There may be additional utility taxes which the utility may add to the power bill. On one hand, cost of fuel is likely to increase, and on the other, amount of fuel consumed per kw.-hr. is likely to decrease, particularly in large plants. Will the change in fuel adjustment on purchased power be balanced by a corresponding change in fuel cost or fuel economy in an isolated plant?

Cost of labor may go up. Will proportional change in cost of purchased energy correspond to that in energy generated in an isolated plant? These are more difficult to analyze, yet must be given serious consideration.

*New York, N. Y.* M. M. SAMUELS

## Further Errors for January What's Wrong

IN THE oil-burner sketch shown in "What's Wrong With This Picture," Jan. *Power*, the following requisites should have been included:

1. Oil tank, if possible, should be placed on saddles and properly pitched to prevent air pockets.

2. Piping should be arranged to prevent any breaks in the oil lines if the tank should settle.

3. Boiler front should be provided with a peek hole for examination of boiler while it is in service.

4. Boiler room should be properly ventilated and should have a fire extinguisher.

5.The vent should be carried outside and have a wire-gauzed gooseneck end.

6. A draft gage, necessary for economical combustion control, is not shown.

7. Stack damper should be cut out in the center or around the edges to make sure that no gas will accumulate in the boiler furnace.

8. A low-water cut-out, essential for disengaging the burner in event of low water, is not shown.

*Buffalo, N.Y.* JOHN J. TIMMONS

## Heat Recovery from Hot Waste Water

I READ with interest Claus Levenson's article, "Recovering Heat From Hot Waste Water," in May *Power*, but find that it does not describe practical operating conditions. During the last 10 years I installed quite a number of so-called heat reclaimers, mentioned in the article, and find that they give excellent results.

Separating hot and cold water has been tried in a number of installations, but has not been found necessary. First, about 70% of all waste water is hot and cold rinse water is discharged at a temperature of not less than 90 F. High temperature of the latter results from heat stored in the washing machine and its contents left from the previous hot rinse. Recording thermometers connected into laundry-water dicharge lines confirm this. Waste water at 90 F can be used to preheat incoming cold water.

Heat reclaimers are never installed in plants with solely two washers, the usual minimum being about six machines. Usually, when one machine discharges hot waste one of the others will discharge cold and the two can be separated only by equipping each with a bypass valve.

Lint, one of the greatest sources of trouble in laundry heat-reclaimer operation, unless removed by screens would make thermal bypass valves useless in a short time. If each washing machine were equipped with such a valve, each would require a screen, to be cleaned or exchanged every few hours. However, these valves may have practical applications in other industries.

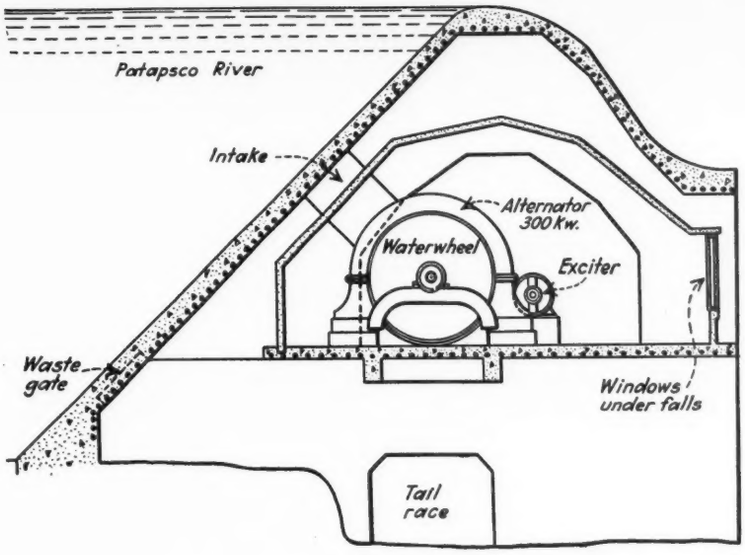
*East Orange, N. J.* A. A. BATO

## Preventing Coal Bridging

AFTER READING answers to the question on how to prevent bridging of coal in a silo, June *Power*, I wish to add a few suggestions. Hanging up of coal in a silo is of course caused largely by bridging. The same thing sometimes takes place in wood-refuse fuel bins. In such cases, a blast of compressed air from a nozzle, permanently located at a strategic point in the side wall, is often sufficient to dislodge the material. For coal, more than one nozzle might be required, as a number of nozzles arranged spirally around the silo in such manner that air could be discharged from any line by a valve.

Some form of mechanical-vibrator unit, projected through the side walls and extended a short way into the bin or silo, is another method that could be used. It would be best to actuate this device electrically by means of a push-button, and would be about as conveniently operated as an air valve.

*Peoria, Ill.* JOHN E. HYLER




## Underwater Hydro Plant In Maryland

ON PAGE 221, April *Power*, some interesting pictures are shown of a new water-power plant on the Persante River in Germany. In the accompanying text this plant is said to be the world's first underwater power station. Near Baltimore, Md., a submerged hydroelectric plant has been in operation since about 1907. The plant is on the Patapsco River near Ilchester, Md., and is owned by the Consolidated Gas, Electric Light & Power Co. of Baltimore. The figure shows a cross section of this plant which probably includes the same principles of construction that are used in the German plant. For economic reasons the plant, which has two 500-hp. water wheels connected to 300-kva. generators, has not been in operation for the past few years.

*Baltimore, Md.* PAUL I. GISIGER

## Trepanning of Welds Is a Useful Test

IN CONNECTION with "Does Trepanning Discover Welding Defects," page 287, May *Power*, the following information may be of interest:

Trepanning of pressure vessels has received due consideration from various sources, and is generally used on unfired pressure vessels to detect poor welding or give evidence of depth of cracks. It is not used on high-pressure boilers because such boilers are X-rayed after completion of welded seams in accordance with the A.S.M.E. Boiler Code. There are no high-pressure boilers in operation with welded joints that have not been X-rayed, which eliminates the reference made in the article to trepanned boiler joints.

A statement in the article that the Boiler Code does not permit an unreinforced hole in a welded joint refers specifically to boilers being built in accordance with the Code and solely to high-pressure boilers. While the A.S.M.E. Pressure Vessel Code does not mention openings in welded seams, the Joint Unfired Pressure Vessel Code of the American Petroleum Institute and the A.S.M.E. (see Paragraph W-314b) does mention the fact that no unreinforced hole shall be placed in a welded seam. However, this portion of the Code is applicable to new work and has no connection with old vessels built prior to acceptance of the Code.

Before the A.S.M.E. Unfired Pressure Vessel Code was adopted, there were many unfired pressure-vessels built by welders, both good and bad. The purpose of trepanning a welded joint is to ascertain as nearly as possible any weld defects in these vessels. Also, many of the unfired pressure vessels built today are not X-rayed, and it is up to somebody to determine the condition of the welds in these vessels when there is any doubt whether the joint meets requirements.

Trepanning is admittedly not infallible, but if one or two sections are removed from a welded joint and found defective, enough evidence is at hand to condemn that pressure vessel, or at least to cancel the insurance. If two or more sections are removed from a welded joint and found to be satisfactory, the entire joint is approximately of the same nature, as it is definitely known that welders who make acceptable welds in test pieces will continue to do so when working on regular work, although a check on the welder should be made at certain intervals. Trepanning is an improvement over a visible inspection, or even a hydrostatic test. Of course, it is possible to "Magnaflux" the weld, but this may not reveal condition of the joint throughout the entire thickness of the metal.

The joint A.P.I. and A.S.M.E. Code will permit reinforcing of holes in a welded joint, and the fact that vessels could be properly reinforced after they are trepanned and plugged would eliminate any violation of that Code. Moreover, two 1-in holes, spaced far enough apart to have no effect on the efficiency of the weld, should not materially weaken the joint.

*Buffalo, N. Y.* JOHN J. TIMMONS

## Conservation of Industrial Water

AS A SUPPLEMENT to "Water Cost Reduced 40%," April *Power*, experiences of a large chemical plant along similar lines may be of interest. Engineers were confronted with the problem of supplying an increase in manufacturing facilities from an available supply already overloaded. The program outlined below, which was instrumental in solving this difficulty, made available additional water capacity for the future and reduced pumping cost.

1. All water sources (deep wells and springs) are metered with permanently installed recording and integrating flowmeters. Information supplied by these instruments enables an engineer to make an analysis and check on total and peak demands.

2. Operations are scheduled wherever possible to space out short-time peaks and prevent them from coinciding or following one another up too closely.

3. Water demand of each plant department is determined with a portable integrating and recording flowmeter used in conjunction with either a pitot tube or orifice. A study of charts from this instrument and those of other flowmeters revealed several bad distribution-system leaks which were located and corrected. After removal of the portable instrument, mercury V-tube manometers were installed permanently on each departmental water main. Calibration curves enable operators to determine quantity of water flowing at any time. Readings taken hourly are averaged daily, and department supervisors made responsible for any waste that these readings may reveal.

4. As the water required is primarily used for condensing, maximum allowable condenser-overflow temperatures were determined. Wherever justified, temperatures are now held at this point with assistance of recording thermometers, temperature controllers, calibrated valves, and in some instances indicating flowmetering equipment.

5. Water from condensers or heat exchangers having a necessarily low overflow temperature is piped to high-temperature condensers and reused. High-temperature overflow water is either used where water is required to wash the product, as boiler makeup, for heating, or is wasted.

6. Light overflow funnels are used wherever water is wasted to supplement other indicating devices.

7. Needle or globe valves are supplied on the inlet side of all bearings, seals, etc., to provide closer and more accurate control.

8. Future plans call for reducing the summer peak when cold water cools air-conditioning units. Spray-pan overflow will be recovered and pumped to the inlet of low-temperature condensing apparatus and thence through re-used water system. Storage tanks will also be installed to provide sufficient capacity for equalizing demands from the various pieces of equipment.

*Roanoke, Va.* S. H. COLEMAN

# READERS' PROBLEMS

## QUESTIONS for Our Readers

### Laying Up Steam Turbines

**Question 1**

WE *have two 200-kw. steam turbines that may be operated condensing or noncondensing. These turbines may be out of service for several months at a time and I would like to know how to treat them so that they will be properly protected against rust and corrosion and at the same time be ready for immediate service. Can* POWER *readers give me the benefit of their experience?*—W.O.R.

### Chatter of D.C. Motor Brushes

**Question 2**

ON A *100-hp. d.c. motor in our plant, the brushes chatter badly. Paraffin applied to the commutator stops chattering only momentarily. Brush holders have been tried in positions where the commutator runs against the brushes and vice versa, without correcting the trouble. Temporary relief was obtained by turning down the commutator. How can this difficulty be corrected?*—J.P.M.

Suitable answers from readers will be paid for if space is available for publication.

## MEASURING TOTAL BLOWOFF

**ANSWERS to May Question 1**

**The Question**

CAN SOME *one tell me a simple way to measure total quantity of blowoff from our boilers? The flow meters in our feedwater and boiler-outlet steam lines are not sufficiently accurate to determine this quantity by difference.*—C.W.C.

### Monel-Metal Orifice Meters Boiler Blowoff

PRELIMINARY calibration of a monel-metal orifice, approximately ¼ in. thick and with a hole diameter to suit the flow desired, has been used to meter both water injection into superheated steam lines and boiler blowoff. Calibration was performed by installing the orifice in a union which had part of its seat machined away, and allowing cold feedwater, supplied through an auxiliary header, to be discharged through a short pipe into a barrel mounted on a scale. If an auxiliary header is not available, discharge hot feedwater into water.

By plotting gage pressure as abscissa and weight of water as ordinate, a smooth curve can be secured over a considerable range to suit whatever pressures are involved.

The orifice, together with its union and a valve ahead of it, is tapped into the blowoff line between the two blowoff valves. Consequently, in operation only the upper blowoff valve is opened and the orifice acts as a bypass around the lower valve. By referring to the curve, rate per hour or minute can be determined and total amount discharged computed.

S. G. HILLIARD *Milwaukee, Wis.*

### Chloride Determination Gives Rough Measurement

BOILER BLOWDOWN can often be measured in smaller steam plants through observation of the fall of water level in any one boiler during blowing down of that particular boiler. This is true where intermittent or periodic blowdown is practiced.

From known boiler dimensions, volume and weight of water expelled can be readily calculated. It is, of course, imperative that no appreciable amount of feedwater be passed to the boiler or that only a minute quantity of steam be liberated from the boiler during the measuring operation. These latter requirements can usually be met with little difficulty, inasmuch as blowdown of boilers is properly carried out during periods of low or zero output. In plants fitted with automatic feedwater regulators, it may be necessary to close feedwater lines or to put regulators temporarily out of service while valves are open and the blowdown operation is taking place.

Another practice for convenient rough control of blowdown quantity involves chemical determination of boiler-water impurities prior to and subsequent to the blowdown valve operation. Through inter-relation of the concentrations so obtained, and with knowledge, again, of water content of the boiler, it is possible to determine amount of water removed during the blowdown operation. The chemical radical usually used as an index to water removal is chloride. That is chosen because of the simplicity of its determination, because of the almost universal occurrence of chloride, and because of the stability that it exhibits in hot boiler solutions.

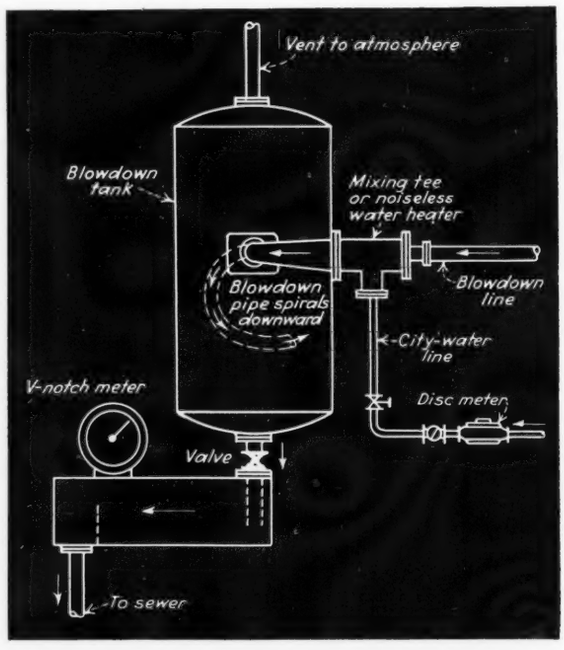
Accuracy in chloride determination is, obviously, somewhat dependent on the existance of a reasonable concentration of the radical in the feedwater used. Chemical control of blowdown is particularly advantageous since it permits direct relation of the water discharge of blowdown to the feedwater quantity, both for the same time. The method, moreover, makes possible a direct check on boiler-water leakage during nonoperation of bottom blowoff valves.

R. E. SUMMERS *Corvallis, Ore.*

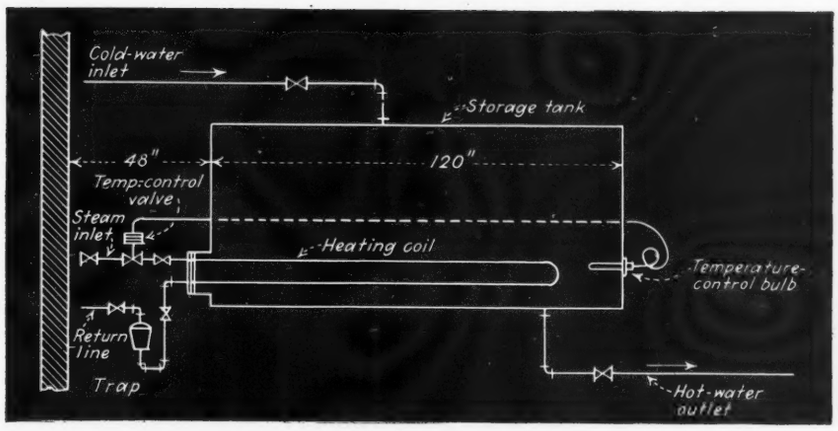
### Meters and Mixing Tank Provide Accurate Measure

THERE IS no simple method of measuring total boiler blowoff correctly. Its quantity can be determined, however, with a high degree of accuracy by using two commercial meters as shown in the sketch. In this system, hot blowoff is cooled well below its atmospheric flash point with a measured quantity of cold water. This mixing and cooling is done in a mixing tee. After mixing, total quantity of cooled water expends its velocity, swirling in the blowoff tank and is then measured with a V-notch type meter. Quantity of blowoff is determined by subtracting the cold-water meter reading from that of the V-notch meter.

City water necessary is usually two or three times that theoretically required, in order to handle instantaneous peaks and avoid flashing and water hammer. The blowoff tank must be sufficiently large to care for any restriction in flow imposed by the size of the V-notch meter or other restrictions in the piping between tank and sewer. It may be necessary to schedule the time of operation of each individual boiler blowoff valve so that capacity of the metering equipment will not be exceeded.




S. C. HARRY, JR. *New York, N. Y.*




## WHAT'S WRONG WITH THIS PICTURE—XVII

**Storage Type Hot-Water Heater**

**THERE are at least 14 errors shown in this drawing. Make a list of those you recognize, then compare with the list on page 410**

## FEED-PUMP VIBRATION

**ANSWERS to May Question 2**

***The Question***

WE HAVE *4-stage boiler-feed pumps which were designed to handle 650 g.p.m. of 300-deg. F water when operating at 2400 r.p.m. with suction head of 209 ft. and discharge head of 1,193 ft. Head developed by the pumps was to be 984 ft.*

*After first inspection and reassembly, the pump was started. It vibrated seriously above speeds of 2,150 to 2,200 r.p.m. The same thing happened to one of the other pumps, and a third started to vibrate after about three years. When it was taken apart, balance device and shaft sleeves were found badly worn. New parts did not stop the vibration.*

*Our operating conditions are not those for which the pumps were designed but are the same as the conditions under which they operated successfully for months. At 2 400 r.p.m., the discharge head is 1,035 ft. and the suction head 225 ft. The vibration persists, even though all design conditions, except temperature, are established.*—B.P.B.

### Check on Misalignment

VIBRATION in this case is not caused by faulty design nor by temperature or pump-head conditions. The cause seems to be simply a matter of driving and driven units being out of line with each other. More than once I have had to reset both large and small high-speed units in true alignment, although these units had been in line when installed.

To realign such units is a simple matter requiring only the use of a steel straightedge, a set of feelers and a steel wedge to be applied around rims of couplings and between faces. First remove all coupling bolts. Loosen holding-down bolts and add or remove shims under supports, and move the units on the base until they are perfectly in line. Then, a feeler cannot be inserted under the straightedge placed across the outside edges of the coupling and the steel wedge enters between the faces an equal distance at any point of the circumference. Bolt units down firmly and try alignment again with feelers. When correct, replace coupling bolts.

Should this fail to effect a cure, I suggest that rotors of both pumps and driving units be removed and balanced on ways. These ways may be easily set up near the job by using a pair of steel parallel bars mounted and levelled on trestles.

A steam-turbine driving unit may be found to be out of balance due to blade wear. This should be corrected by blade renewal where possible. Failing that, defective blades may be dressed up and balanced by drilling small holes near the rim to re-establish balance.

GEO. MCNALLY *Kearny, N. J.*

### Four Results of Above-Design Temperature

IF THE pump ever ran quietly at the speeds and temperature mentioned, there is nothing in its hydraulics to cause trouble. The original temperature was not duplicated, according to the question. It may be assumed that there has not been a great increase in temperature, but if temperature is somewhat higher than that for which the pump was sold there are four sources of trouble:

1. Vaporization in first-stage impeller eye. This is accompanied by noise and vibration and would have to be referred to pump manufacturer to see if an impeller with a larger eye could be installed.

2. Casing distortion caused by effect of temperature change on unsymmetrical casing design. This is a fundamental difficulty and can not be corrected, but can be alleviated to some extent by lagging pumps to keep temperature uniform and by warming them for about an hour before pumping hot water.

3. Rotor distortion. This takes place in any pump used on high-temperature service, but does not usually cause trouble. When pumps operate at high temperatures, rotors should be rotated slowly until warmed up. It has been found insufficient merely to warm pumps without rotating when distortion is marked.

4. Misalignment caused by piping-expansion strains or by pump expansion. The remedy lies in checking and correcting piping with this in mind and aligning the pump hot. A flexible coupling that will compensate for slight misalignment errors should be used.

If there is no temperature effect involved, then the problem is entirely a mechanical one. To check this, first uncouple the turbine and be sure it runs without vibration. Then go over the pump as follows:

Impellers must be in good static balance. Check this by putting each impeller on a mandrel between centers or preferably on ways, and remove a little metal from side walls where necessary. Keyway should be filled with a half key during the balancing operation. Check balance of coupling halves and balancing drum the same way. Be sure shaft is absolutely straight. Assemble rotor loosely and check balance.

It is essential that rotor parts including the coupling be snug fit on the shaft. A clearance of more than 0.002 in. is excessive. Faces of impeller hubs and intermediate sleeves, if any, should be perfectly clean. Any marks should be dressed down so that there will be no high spots to spring the rotor shaft.

Now run up nuts or shaft sleeves on rotor firmly. It is important that these be drawn up good and tight. With the rotor on ways, check various parts for run-out. This should not exceed 0.004 inch. It is not necessary to use dynamic balancing equipment.

Pump and turbine bearings should be checked to be sure they are in reasonably good condition.

Piping should be well supported.

Machines should be on a good foundation. If they are mounted on the floor of an upper story, it is possible that the floor may be too flimsy, in which case a column or two directly below the machinery may reduce harmonic vibration.

M. J. RANKINE *Philadelphia, Pa.*

### Fourteen Suggestions

THERE ARE so many possible sources of vibration in a multi-stage centrifugal boiler-feed pump that a good deal more information is required to establish the definite cause. If the source can be determined, the remedy will usually be self-evident. Cause of vibration may be mechanical or hydraulic. This may result from improper maintenance, misapplication or incorrect design. The following outline gives some of the common causes of vibration, and indicates a few of the possible remedies.

**Mechanical Defects**—(1) Misalignment in reassembly—Check coupling, bearings, size and condition of gaskets, and alignment of pump and driver on bedplate when both are running at operating temperatures. (2) Excessive wear on balancing device—Replace worn

parts. (3) Incorrect assembly—Impellers may be interchanged; sleeves, diaphragms and bearings may be loose or incorrectly assembled. (4) Rubbing—Check diaphragms, shaft sleeves, shaft nuts, stuffing-box bushings, glands, wearing rings, balancing device.

(5) Bearings overloaded—Due to increased rating, load may exceed capacity of bearings; refer to manufacturer. (6) Critical speed—Increasing speed may have brought shaft into critical-speed range. (7) Driver—Check driver as a possible source of the vibration. (8) Water-ways blocked or partially plugged by scale or foreign matter from pipe system.

**Hydraulic Defects**—(1) Insufficient suction head for temperature of water being pumped. (2) Insufficient suction head for capacity handled and speed at which pump is operated. (3) Unsuitable impeller and waterway design, often not evident until normal wear has increased leakage.

(4) Boiler regulator unstable or causes pump to operate for appreciable periods of time at very low capacities. Use bypass so that capacity is never less than 10-20% of full capacity. (5) Velocities in pump greater than intended when designed. Pump parts too light for pressure, speed, and power now used. (6) Pumps may have unstable characteristic curve; refer to manufacturer.

G. F. HABACH *Orange, N. J.*

## A Complete Analysis Of the Problem

CONDITIONS described by R.P.B. are not sufficiently distinctive to allow an unerring diagnosis of this specific pump problem. Though vibration and other symptoms cited may be results of any one of several causes, it remains, however, to list them and to suggest possible remedies.

The first and simplest explanation is that vibration, which developed after the pump had been inspected for the first time, is being caused by misalignment after reassembly. At the high temperature at which this pump operates, expansion greatly magnifies any misalignment. Where boiler-feed pumps are steam-turbine driven, final alignment should be made with the driver heated to its operating temperature, and allowance made for the pump-shaft position when the pump handles 300-F water. In other words, alignment should be made under operating-temperature conditions.

Excessive wear on pump rotor or in pump bearings could cause misalignment of pump and turbine shafts. Vibration resulting therefrom would be accentuated if, on replacing the upper casing half after inspection, excessive stress was applied to casing bolts, causing a flattening of casing halves to bring stationary and revolving parts of the pump into contact. If the pumps are of the diffuser type, this effect would be very much enhanced.

Improper design of the balancing device could also result in severe pump vibration, which would develop after a few months' operation. If balancing-device design made impossible perfect pump balance, the pump thrust bearing might be carrying a heavier load than that for which it was designed; consequently, thrust bearing life would be materially shortened.

Cavitation in the first-stage impeller is another frequent cause of vibration. Cavitation is the phenomenon that takes place in a pump when water pressure approaches its vapor pressure at the existing pressure, causing a liberation of vapor bubbles in the water. In addition to its objectionable effects on various pump parts, it generally upsets pump-thrust balance and causes vibration and wear. Cavitation results from insufficient head on the pump suction to fill impeller waterways. In this particular case, the trouble could be traced either to faulty design (if first-stage impeller waterways were not of a size consistent with the suction head available), or to improper operation (for instance, if source of feedwater was carried at lower level than that recommended by the manufacturer).

There are other possible reasons for cavitation and vibration. When the pump was reassembled an impeller of the last three stages may have been located in the first stage. Normally, the first-stage impeller has larger entrance areas in order to handle design capacity without cavitation. If impellers had been switched around, the first-stage impeller would probably be subjected to severe cavitation.

If during reassembly of the balancing device, clearance had become too large, excessive leakage flowing back into the suction through the balancing pipe would appreciably increase actual capacity handled by the first-stage impeller and would likewise result in cavitation. A possible remedy would be to throttle the balancing-pipe valve. At the same time, thrust-bearing temperature should be carefully watched, in order not to destroy the pump's axial thrust balance, which would completely stop flow through the balancing device.

A pump operated for a considerable period with the discharge valve almost completely closed will develop serious troubles, unless a bypass is provided so that the pump will never handle less than 15% of its design capacity. This precaution is necessary to prevent overheating water within the pump casing and causing cavitation. It is obvious that hydraulic losses corresponding to low efficiency of a pump at low discharge are transformed into friction and heat. If that heat is not dissipated it will raise water temperature appreciably. Even if cavitation phenomena were not to take place, resulting expansions would greatly endanger successful operation of the pump.

I. J. KARASSIK *Harrison, N. J.*
*Worthington Pump & Machinery Corp.*

## WHAT'S WRONG WITH THIS PICTURE—XVII

***Storage Type Hot-Water Heater—See Page 409***

*1. Cold-water inlet at top of storage tank.* If a heater were connected in this manner, its normal circulation would be destroyed and its heating efficiency seriously impaired. Cold water should enter at the bottom and hot water leave at the top.

*2. No manhole in tank.* In a vessel of this size, a manhole must be provided to facilitate cleaning and inspection.

*3. No drain connection in bottom of tank.* A drain or blowoff valve is required to assist in the removal of sediment deposits both while the tank is under pressure and when washing out with the manhole open.

*4. No relief valve on tank.* A relief valve is necessary to protect the vessel against destructive over-pressure and water hammer.

*5. No supports for coil.* With a heating coil of this length, supports are needed to prevent sagging and pocketing of the tubes.

*6. Temperature-control-valve bulb improperly located.* This bulb should be placed in the upper part of the tank at some point where the maximum storage capacity can be utilized with a reasonable degree of control of hot-water outlet temperature.

*7. Insufficient clearance between end of tank and wall.* With this clearance, it is obviously impossible to withdraw the heating element for repairs or other reasons.

*8. No thermometer in hot-water line or on tank.* Some means of indicating temperature must be installed so that heater can be controlled.

*9. No bypass around temperature-control valve.* This is needed so that the valve can be taken out of service for repairs without shutting down the heater.

*10. No strainer in steam line ahead of temperature-control valve.* Dirt must be prevented from entering any control valve if it is to continue to function properly.

*11. No vacuum breaker on heating coil.* A vacuum breaker should be installed to prevent hammering caused by fluctuating loads.

*12. No air-vent valve on heating coil.* An air-vent valve is required to avoid air-binding when load fluctuates. It will relieve the trap of the burden of handling large quantities of air.

*13. No bypass around trap.* A bypass should be installed so the trap can be isolated for repairs.

*14. No check valve in trap discharge line.* A check valve should be used to prevent back-flow of condensate from the return line into an idle heater.

S. H. COLEMAN *Roanoke, Va.*

# THE ENGINEER'S BOOKSHELF

## Fluid Mechanics

FLUID MECHANICS (1937)—*By Russell A. Dodge, Associate Professor of Engineering Mechanics, and Milton J. Thompson, Assistant Professor of Aeronautical Engineering, University of Michigan. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 495 pages, 6x9 in., 267 illustrations, 12 tables. Price $4.00.*

Much of the material previously published on fluid mechanics has been highly mathematical and suitable for use by only expert mathematicians. In this text book, the authors have succeeded in making the subject understandable to the college student with the usual foundation in physics, mathematics and mechanics. Work done in the many hydraulic and aerodynamic laboratories during the last 25 years has brought a great increase in our knowledge of fluid mechanics, much of which has been included in this book.

Subject matter is divided into statics and dynamics of fluids and is presented in 16 chapters: properties, statics, flotation, accelerated liquids in relative equilibrium, dynamics, impulse and momentum, dynamic lift and propulsion, flow of viscous fluids, flow in pipe lines, flow with a free surface, flow through orifices and tubes, resistance of immersed and floating bodies, dynamics of compressible fluids, thermodynamics of compressible viscous fluids, dynamic similarity and special problems in fluids mechanics.

The book should also be useful to the practicing engineer, and over 400 problems with answers add much to its practical usefulness.

## Electrical Trouble-Shooting

TROUBLES OF ELECTRICAL EQUIPMENT (1936)—*By H. E. Stafford. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 330 pages, 6x9 in., 297 illustrations, 22 tables. Price, $3.*

In this book, the author has classified in tables motor and other electrical-equipment troubles and remedies, one table for each class of apparatus. Each table has four headings under which symptoms, possible troubles, causes and remedies are tabulated, so that information may be quickly applied.

The volume is divided into 17 chapters: induction-motor troubles and remedies; synchronous-motor troubles and remedies; maintenance of d.c. generators and motors with their troubles and remedies; operation, maintenance and troubles of transformers; troubles of air and oil circuit breakers and relays; industrial motor control; points to remember when selecting motors for industrial applications; operation, maintenance and troubles of lightning arrestors; insulation-resistance tests; factors determining economic use of power; power factor, what it is, what it does to an industrial-plant power load and how to control it; handling maintenance and inspection on a schedule basis; value of load surveys and how to make them; troubles of voltage regulators, their symptoms, causes and remedies; and industrial plant lubrication.

This book is an expression of the author's over 30 years' experience as an erecting and maintenance engineer. It is written from the practical operating man's viewpoint, and contains much useful material for everyone interested in electrical machinery and circuits.

## Electricity

ELEMENTS OF ELECTRICITY (1937)—*By William Esty, Robert A. Millikan and Wynne L. McDougal. Published by American Technical Society, Chicago, Ill. 248 pages, 8½x5½ in.; illustrated.*

A book on the elements of magnetism and electricity written for those interested in qualitative rather than quantitative results. Mathematics have been practically eliminated and illustrations show how electrical and magnetic devices operate. Ten chapters cover such subjects as magnetism, current electricity, elementary circuits, Ohm's law, series and parallel circuits, light and power circuits, electric-bulb and signal systems, induced currents, transformer construction and storage batteries. Students of elementary electricity and practical electricians should find this book helpful.

## Engineer's Year Book

KEMPE'S ENGINEER'S YEAR-BOOK (1937)—*Compiled and edited under the direction of the editor of* The Engineer. *Published by Morgan Bros., Ltd., 28 Essex St., Strand, London, England. Almost 2,700 pages, 4½x7¼. Price 31 shillings, 6 pence.*

A "World Almanac" for engineers, this is the 43rd annual edition of a book dealing with every phase of modern engineering practice. The first and largest part of the volume is, of course, devoted to actual technical information, in which may be mentioned sections on lubrication, viscosity of oils, shafting and shafts, pumps and pumping, thermo-dynamics, steam, steam-generating equipment, engines, condensers and turbines, internal combustion engines, fuels, power transmission, heating and ventilating, and refrigeration. All information is concise and well illustrated with formulas, diagrams and charts.

The second part contains particulars on products made by a number of engineering firms and shows practical applications of principles and data. It is, on the whole, very thorough and may be called a library in itself, in so far as that is possible.

## Thermodynamics

THERMODYNAMICS (4th Edition—*By J. E. Einswiler, Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 6x9 in., 357 pages, 162 illustrations. Price, $3.*

The fourth edition of this well known and accepted text on thermodynamics has been improved and brought up to date by the addition of new material on water-vapor refrigeration and steam-and-air mixtures, thus giving basic information necessary to air conditioning. 42 new problems have been added to the 89 in the last edition.

### BRIEF REVIEWS

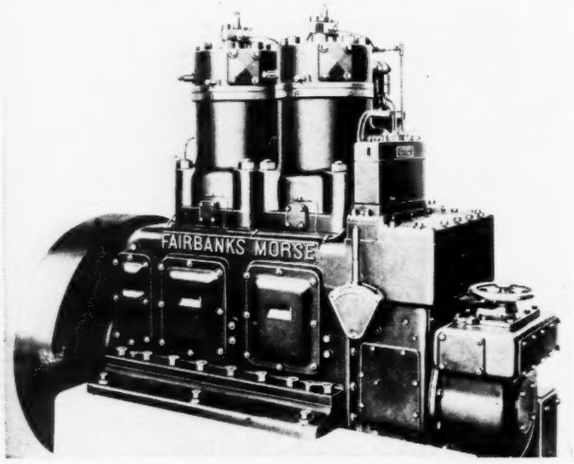
HEAT TRANSFER IN EVAPORATION AND CONDENSATION (1937). *Free from Engineering Experiment Station, University of Illinois, Urbana, Ill. A reprint from* Mechanical Engineering, *Oct. and Nov., 1936.*—75-page report on heat transfer during condensation and evaporation, including experiments on latent heat of high-pressure steam.

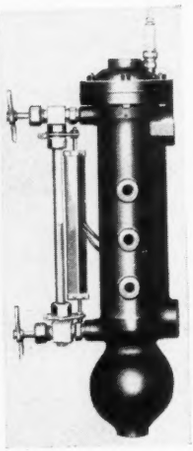
USE OF AN ELBOW IN A PIPELINE FOR DETERMINING RATE OF FLOW IN THE PIPE AND INVESTIGATION OF SUMMER COOLING IN THE WARM-AIR HEATING RESEARCH RESIDENCE (1937). *Free from Engineering Experiment Station, University of Illinois, Urbana, Ill. Ask for Bulletins 289 and 290*—First bulletin describes tests made on threaded and flanged elbows and the conclusion that 90-deg. elbows may be used sucessfully as flowmeters. The second describes tests on various types of cooling equipment made during three successive summers.

ALIGNMENT CHARTS—THEIR CONSTRUCTION AND USE (1936). *By Paul N. Lehocsky. Published by Engineering Experiment Station, Ohio State University, Columbus, Ohio. Circular No. 34, price 40 cents*—Shows how to make alignment charts with a modest expenditure of time and money. No mathematics beyond simple geometry and algebra needed to follow explanations. A large sheet inserted in the jacket permits direct copying of uniform and logarithmic scales of all sizes.

DIRECTORY OF NEW ENGLAND MANUFACTURERS. *Published by Geo. D. Hall, Inc., 665 Boylston St., Boston, Mass. Price, $15*—17,000 New England manufacturers are listed, together with names of principal officers. Also included are descriptions of products made, number of employees, capital and location of plants and branch offices. A second section classifies concerns by state, city and town, and a third lists alphabetically all products together with names and addresses of manufacturers.

# WHAT'S NEW IN PLANT EQUIPMENT

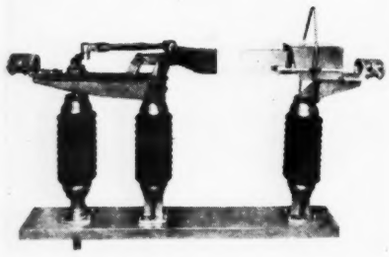


### HEAVY-DUTY DIESEL

MODEL 42-E has mechanical injection and crankcase scavenging. 2 and 3 cyl., 60 and 90 hp., 450 r.p.m., 8¾-in. bore, 10½-in. stroke. Direct connection, belt or electric-generator drive. Manufacturer states engine is designed for limited space and head room, and is applicable for any power requirement within engine's horsepower rating.

*Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.*



### AIR-BREAK SWITCH

BLADE-OPERATING mechanism constructed to lock levers and linkages securely after initial setting is made. Future blade adjustments are made on interconnecting steel pipes underneath mounting base. Operating pipes have drop-forged clamp fittings, in turn equipped with piercing-type set screws which, after final switch adjustments, are turned down until they punch holes in pipe to form absolute locking points. Rated 2,000 amp., 34.5 kv.

*Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*

### ASBESTOS SHEET PACKING

"PRENITE 20M", a sulphur-free, "Neoprene"-bonded, compressed asbestos sheet said to offer great resistance to oil and refrigerants such as Freon, methyl-chloride and sulphur dioxide. Made in 50x50-in. sheets of 1/32-, 1/64- and 1/16-in. thickness.

*B. F. Goodrich Co., Akron, Ohio.*

### NEON ILLUMINATOR FOR WATER GAGES

NEON-LIGHT tube and magnifying lens are attached behind water gage by two screw clamps which grip around top and bottom gage fittings. Water- or liquid-filled part of gage glass stands out as broad red band; empty space above appearing as hair-line red stripe. Said to make readings very distinct, either day or night.

*Wright-Austin Co., 315 W. Woodbridge Ave., Detroit, Mich.*

### INSULATION

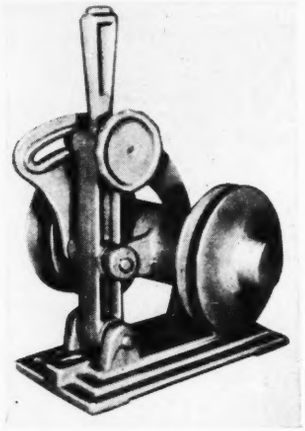
"MIKOLITE", cork-like mineral insulation, made from micacious ore heated under 2000 F for 16 sec. and expanded to approximately 20 times original size. Weight changes from 80 to 7-12 lb. per cu.ft. and becomes porous. Said to be highly insulative, fire-proof, moisture-proof and impervious to decay. Manufacturer claims it capable of withstanding mixing with binders such as cement, mortar, etc.

*Mikolite Co., 1317 Union Ave., Kansas City, Mo.*

### VARIABLE-SPEED CONTROL

SINGLE SHAFT has two adjustable V-belt pulleys which vary in diameter as their distances from driving and driven pulleys are changed. Said to be over 90% efficient, and to offer infinite speed selectivity within ratios of 5 to 1. Size range of ¼ to 7½ hp.

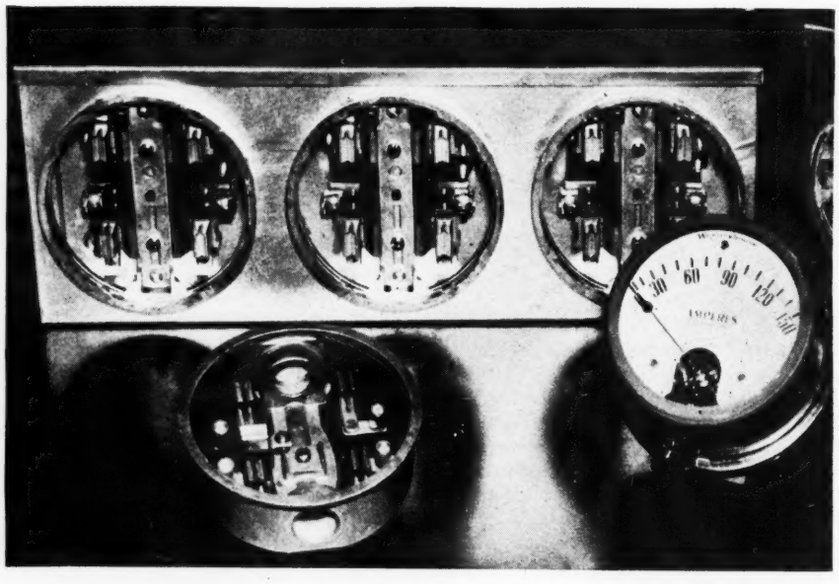
*Columbia Vari-Speed Co., Wheaton, Ill.*



### PLUG-IN INSTRUMENTS

DETACHABLE instruments consist of two units: a socket with electrical connection jaws, and instrument mechanism mounted on a plate having electrical connection blades on the back and enclosed in weatherproof glass housing. Advantages said to be: (1) socket provides its own switchboard, (2) various instruments can be plugged in same socket to obtain volts, amperes, watts, power factor, kilowatt hours, etc., and (3) sockets can be installed and sealed off to provide convenient outlets for future installation of instruments or making connections for portable analyzers for periodic testing.

*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



### AUTOMATIC AIR ELIMINATOR

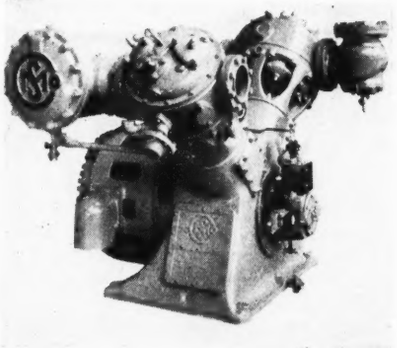
FOR VENTING driers, steam coils, traps, etc., under operating pressures up to 150 lb., nickel-plated bronze air eliminator has non-corrosive metal operating member which closes valve at 212 F and keeps it closed until temperature drops below boiling point. 2½-in. diameter, 4⅝-in. overall height, ½-in. bottom pipe connection. 3/16-in. diameter air outlet.

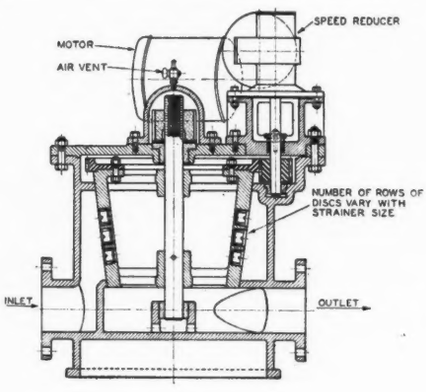
*Gorton Heating Corp., Cranford, N. J.*

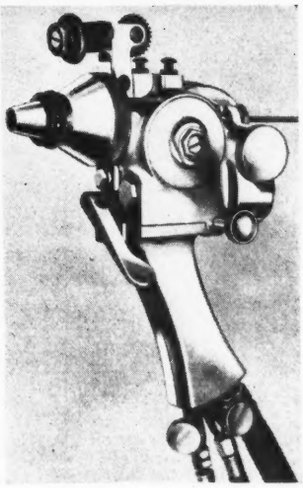
### AIR COMPRESSOR

FOR HEAVY-DUTY service, Class WN-112 compressor will operate on any type drive, but said to reach greatest efficiency with built-in motor. Displacement sizes of 378, 480, 642 and 800 cu.ft. per min. "Dual-cushion" valves, alloy parts. With built-in motor, unit requires 6x8 sq. ft. floor space.

*Sullivan Machinery Co., Michigan City, Ind.*





### METAL-SPRAY GUN

WILL HANDLE wire from 0.032 to 0.125 in. Single monel and bronze valve controls flow of acetylene, oxygen and air simultaneously. In addition, independent valves permit separate adjustment of acetylene and oxygen. Air-ventilated nozzle said to eliminate backfire. All ball bearings, gears and worms lubricated from one point. Range of all metals melting up to 4800 deg. F.

*Metalspray Co., Inc., 113 Llewellyn St., Los Angeles, Calif.*

### PAPER-STOCK PUMP

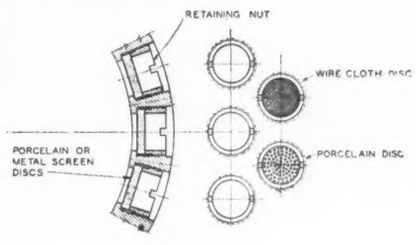
FOR PAPER STOCKS of all kinds and consistencies up to 6½% and higher, this pump is claimed by manufacturer to be non-overloading, -clogging and -air-binding. Angle-split casing and bearing housing said to safeguard against misalignment; oversize shaft, mounted on ball bearings, prevents deflection. Non-clogging impeller a patented feature. 6 sizes in capacities from 100 to 3,500 g.p.m. Bulletin W-360-B1.

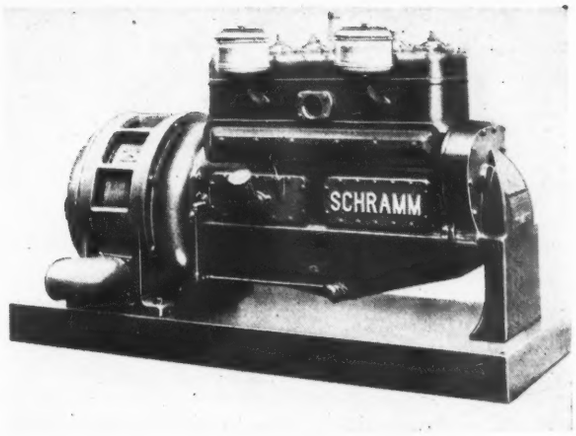
*Worthington Pump & Machinery Corp., Harrison, N. J.*

### AUTOMATIC STRAINER

SELF-CLEANING strainer consists of conical drum revolving in a cast-iron housing. Side of drum has 1⅛-in. holes with screening disks held in place by retaining rings. Screens may be brass, Monel metal, stainless-steel cloth or new type porcelain filter. Cylinder is revolved slowly by self-contained motor and on each revolution filter disks pass by washout connection where reverse flow automatically cleans filters. For industrial services where foreign material must be removed from a large quantity of fluid.

*H. A. Brassert & Co., 310 S. Michigan Ave., Chicago, Ill.*

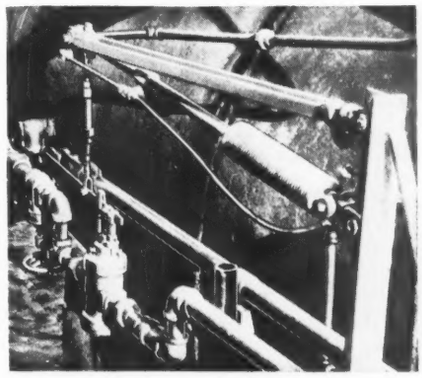



### STATIONARY AIR COMPRESSOR

"UTILITY" COMPRESSOR said by manufacturer to be especially designed for industrial plants. Mechanical intake valve in compressor block is operated from camshaft in timing with piston travel; main bearings intersperse every cylinder; force-feed lubrication. Manufactured for either V-belt drive or direct coupling to electric motor. Size range of 85 to 420 cu.ft. air delivery per min. Bulletin 3-707-PO.

*Schramm Inc., West Chester, Pa.*



### FEEDWATER-LEVEL CONTROL

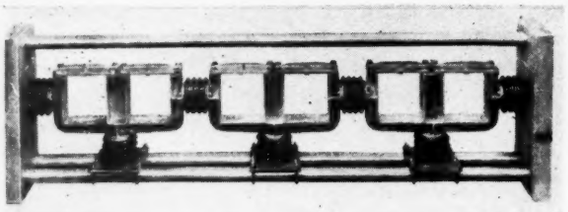
WHEN WATER level drops in gage glass, water runs down inclined tube, which is exposed to temperature of steam at boiler pressure. Expansion of tube causes end casting to move upward and open valve. When water rises in gage, cooling action of water causes contraction which lowers end casting and closes valve. Automatic, will operate on any valve up to 12 in., over-all length 48 in. Illustration shows control mounted on fire-box boiler; different mountings for return-tubular and water-tube boilers.

*J. A. Campbell Co., P. O. Box 851, Long Beach, Calif.*

### ALLOY-STEEL WRENCHES

HEAVY-DUTY, drop-forged, alloy-steel, box-socket wrenches made in straight, off-set and angle types with openings from 1¼ to 3½ in. Tubular extensions provided to slip over forged handle and permit leverages up to 30 to 1. Striking sleeves protect handles when nuts are loosened or set in close quarters with hammer.

*Armstrong Bros. Tool Co., Chicago, Ill.*



### 3-PHASE BUS SUPPORT

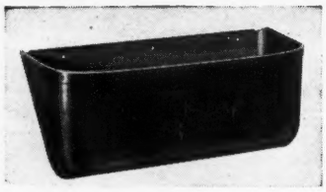
SELF-CONTAINED unit for mill service is 75 in. long and supports six (2 per phase) hollow-square, ventilated 6-in. copper conductors on a short 220-volt switchboard bus. Clamps have rollers to permit bus expansion without stressing porcelain insulators. Interphase and end insulators maintained in compression with three pipes threaded into end plates.

*Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.*

### NOISELESS PILLOW BLOCK

"CUSHIONED-BRONZOIL" bearing, developed for fan and blower service, has synthetic-rubber insulating band enclosing inner unit. Bronze bushing is oiled by capillary action from reservoir in cast-iron inner housing. Inner unit supported on split pressed-steel outer housing said to be self-aligning. Slotted holes in bearing base for easy alignment of fan or blower rotor.

*Dodge Mfg. Co., Mishawaka, Ind.*



### ELEVATOR BUCKET

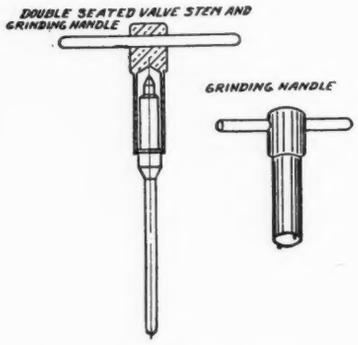
"SUPER SALEM" bucket reinforced at digging lip, front corners and along back. Made in 2½ x 2½ to 30 x 8-in. sizes, either steel, copper, brass, aluminum, monel metal, or stainless steel. Additional strength and greater resistance to wear are claimed for this construction, without increase in weight.

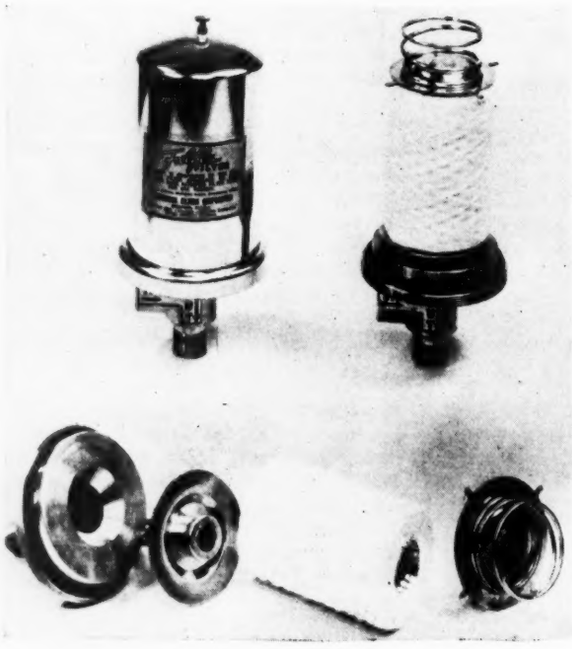
*Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.*

### VALVE-GRINDING HANDLE

FOR its "Vigilant" feedwater regulator, manufacturer has designed valve-grinding handle shown in sketch. Any wear on upper (steam) valve of double-seated valve stem is revealed by steady flow of steam from exhaust when counterweight is up. If cause is failure of valve to seat, it is corrected by turning set screw on bridle arm. If steam still flows, valve is ground in.

*Chaplin-Fulton Mfg. Co., 28 Penn Ave., Pittsburgh, Pa.*



### FUEL-OIL FILTER FOR DIESEL ENGINES

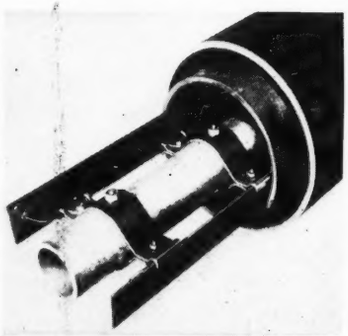
"FULFLO" filter tube constructed of cotton yarn and wound into tube form upon a metal core. Filter tube is mounted on two seat plates having patented recessed centre which seals both ends to prevent bypassing of unfiltered oil. Tube assembly is held in place in filter shell by spring tension to compensate for varying pressures. Manufacturer states filter-tube replacements can be made in less than a minute by unscrewing ring which attaches shell to filter body. Bulletin 1000.

*Commercial Filters Corp., 89 Broad St., Boston, Mass.*

### ELECTRIC HOISTS

"LOAD LIFTER JUNIOR" built in sizes to lift 350 and 700 lbs. Lifting speed of 20 ft. per min. with rated capacity loads. Push-button control unit suspended from hoists. Enclosed ball-bearing motor, electrical motor brake and automatic mechanical load brake. Gearing and mechanical-load brake operate in oil bath. Weight 185 lb. complete.

*Shaw-Box Crane and Hoist Co., Inc., Muskegon, Mich.*



### OIL CHILLER

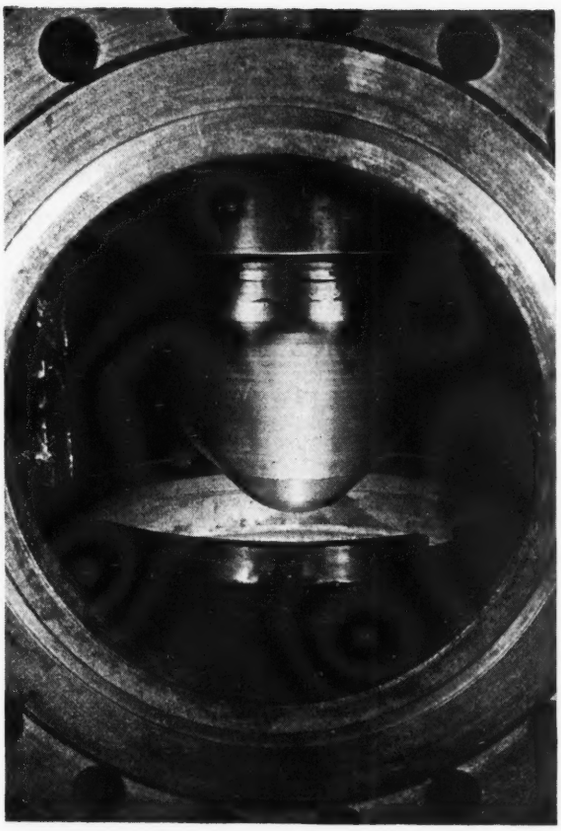
SHELL-AND-TUBE unit, for multiple-stage chilling of cold test oils, rapid refrigeration, etc., has 1170 sq.ft. effective chilling surface. One packing gland to 146 sq.ft. of chilling surface and special design said to prevent loss of solvent. Specially designed scrapers keep tube surfaces clean of wax. Bulletin 37300.

*York Ice Machinery Corp., York, Pa.*

### ELECTRODE FOR FILLET WELDING

"FLEETWOOD 8" electrode said to eliminate necessity of multiple-pass welding in production of fillet and lap welds and to permit production of such welds without undercutting or overlap. Fillet welds up to ⅜ in. with one plate vertical can be made in one pass. Tensile strength of weld metal as deposited 68,000 to 72,000 lb. per sq. in. 14- or 18-in. lengths.

*Lincoln Electric Co., Cleveland, Ohio.*



**FLOW-CONTROL VALVE**

**This valve, perhaps the largest parabolic-disk flow-control valve ever built, was made by Edwards Valve & Mfg. Co., Inc., to control, with uniform pressure drop, a flow of steam over a range of 100,000 to 350,000 lb. of steam per hr. The valve is operated by a Cutler-Hammer valve-control unit. The 16-in. parabolic disk and seat are Stellited; over 16 lb. of Stellite were used to hard-surface the disk alone**

# POWER LINES

## R. H. Macy & Co. Adds 1,000-hp. Diesel Unit

R. H. Macy & Co. is again enlarging the power plant in its department store at 34th St. and Broadway, New York City, with the addition of a 1,000-hp., 600-r.p.m., 8-cyl., 4-cycle McIntosh & Seymour diesel engine direct-connected to a 700-kw., d.c. Crocker-Wheeler generator. This is the third 700-kw. diesel-driven unit and will bring plant generating capacity to 6,450 kw.

In addition, air conditioning of the basement and first four floors of the store requires 1,600 tons of refrigeration, which is supplied by three turbo-compressors. One unit is driven by a 910-hp. high-pressure turbine exhausting at about 5 lb. backpressure. Two smaller units are each driven by a 410-hp. low-pressure turbine, taking steam at about 5 lb. gage and exhausting into a 26-in. vacuum.

Total load on the Macy plant had increased to such an extent that in 1936 steam produced amounted to 496,256,100 lb. and 20,166,640 kw.-hr. were generated. The last addition to the plant, a 1,000-kw. mixed-pressure turbo-generator, was made in 1933. In 1932, steam load was 411,000,000 lb. and power load over 16,000,000 kw.-hr., so that in the past four years steam load has increased 85,000,000 lb. and electrical load 4,000,000 kw.-hr.

The daily peak load for a large part of last year was approximately 5,000 kw., at times reaching over 5,100 kw. Under these conditions, only one 250-kw. unit was available for reserve and made imperative the addition of a new unit. The diesel was selected after an exhaustive study by Kaiser, Muller and Davies, consulting engineers, of every possible means of supplying the required power at lowest cost. A complete report on the plant and the engineering analysis preceding the installation will appear in August *Power*.

## Niagara Hudson Power Corp. Planning Expansion Program

Floyd L. Carlisle, chairman of the Niagara Hudson Power Corp., recently told the Public Service Commission that his organization will need to spend at least $100,000,000 in the next five years to build additional generating plants and distribution facilities to serve its customers. This, he said, provided that no major setback occurred, such as a European war or radical inflation.

Engineers of the Niagara Hudson system are now engaged in drawing up plans for expansion of plant facilities. It has been indicated that a giant steam station is planned in the vicinity of Albany along the Hudson River, and other plant sites are being considered. Superposed units may be installed in steam plants now in operation to permit carrying additional load.

## A.S.M.E. Oil and Gas Power Div. Will Meet August 18-21

The annual summer meeting of the A.S.M.E. Oil and Gas Power Division will be held at Penn State College, Aug. 18-21. Technical sessions for the meeting will include papers on new developments in the diesel and gas engine fields, reports of research on fuels and injection apparatus, latest information on automotive and railroad diesel-engine applications, the annual report on oil engine power cost, a review of metallurgical advances, and discussions of operating problems.

## 2000 Utility Executives Convene in Chicago

Nearly 2,000 utility executives from all over the nation gathered in Chicago on June 1 for the fifth annual convention of the Edison Electric Institute. As usual in E.E.I. conventions, such problems as sales promotion, public and customer relations, and the relation of government to the industry, held the spotlight.

The sessions, all held at the Palmer House and extending through four days, were well attended. Most of the officers, including C. W. Kellogg, president, were elected for another term. Following are some facts and comments of engineering interest included in certain papers:

Air conditioning, said Earl W. Gray of Oklahoma Gas & Electric Co., offers the utilities a spectacular opportunity for load building. The O.G.&E. now has 490 air conditioning or washing installations totalling 6,600 hp. The company serves a total population of 635,000 in 238 communities. Restaurants and retail stores have offered the most accessible market. Domestic installations have been harder to sell, but eventually, Mr. Gray predicted, every home costing over $7,500 will be air conditioned. Today a theater cannot operate without air conditioning. It will soon become a necessity in every retail store, office building, restaurant, hotel and hospital. In the past 12 months, said Mr. Gray, the national utility air-conditioning load has increased 130%.

### Value of Interconnections

Philip Sporn, vice-president and chief engineer of American Gas & Electric, pointed to the Ohio valley floods of '36 and '37 as demonstrations of the emergency value of interconnection between utility companies. But interconnection, he said, saves money in routine operations as well. He warned, however, that long-distance power transmission, so appealing to the public, can rarely be justified on a dollars-and-cents basis.

H. P. Liversidge, vice-president of Philadelphia Electric Co., discussed the long-term prospects for young men entering utility organizations today. Challenging the talents and imagination of young engineers, he declared, is the present waste of 70% of the fuel heat released in power generation. A large reduction in this loss would likewise

make stations less dependent on large supplies of condensing water. The application of direct-current high-voltage transmission was suggested as another opportunity for the new generation of engineers.

A new electrostatic air cleaner was described by Dr. L. W. Chubb, director of Research Labs, Westinghouse. This unit, he claimed, removes the extremely fine particles (e.g., those of tobacco smoke) which pass through mechanical filters and washers. Unlike the electrostatic precipitators used to clean flue gas the air-cleaning unit does not deliver noxious ozone and nitrogen oxides.

Recounting many of engineering's contributions to society, R. C. Muir, vice-president in charge of engineering, General Electric Co., pointed to the growth of station fuel economy. In 1920 it took 41 million tons of coal to produce 27 billion kw. hr. Utility coal consumption was the same in 1934, but output rose to 57 billion kw. hr. If all stations were as good as today's best, this output would require only 26 million tons.

Other advances listed by Mr. Muir included metals for high-pressure, high-temperature steam, and the use of hydrogen in rotating electrical machinery to cut windage losses and improve cooling. Hydrogen reduces windage losses to one-fourteenth that with air. The improved heat removal increases the kw. capacity of a machine of given dimensions about 25%. Hydrogen-cooled generators now under construction total more than 1,000,000 kw.

On the final day of the convention, June 4, the Consolidated Edison Co. of New York, Inc., was awarded the annual award for 1936 of the Charles A. Coffin Foundation, established by General Electric Co. The award, comprising the Charles A. Coffin gold medal, a certificate, and a check for $1,000 to be deposited in the treasury of the Consolidated Edison Employees Mutual Aid Society, Inc., was in recognition of improvement of consumer relations, refunding of bonds, and reorganization of units. The committee of judges also gave recognition to the difficulties in serving the types of area in which Consolidated Edison Co. operates.

## Dissolved Oxygen

M. C. Schwartz and W. B. Gurney of Louisiana Steam Generating Corp., Baton Rouge, La., have called attention to an error being made in the application of their method for determination of dissolved oxygen (Determination of Traces of Dissolved Oxygen by the Winkler Method. Proc. A.S.T.M. 34 II, 796 1934). Potassium bi-iodate should be added in the titrating vessel after the sample is "fixed", not in the sampling flask.

Although the procedure and, in particular, the above point, have been described in detail in Bulletin No. 21 of the Louisiana State University Press (Dissolved Oxygen in Boiler Feedwater, University Studies No. 21, 1935), the apparently limited circulation of this publication has made it advisable to call attention to this particular point.

# MEETINGS

**American Society for Testing Materials**—*Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y., June 28-July 2. R. E. Hess, assistant secretary, 260 South Broad St., Philadelphia, Pa.*

**American Welding Society**—*18th Annual Meeting and Exposition, Oct. 18–22, Hotel Traymore and Convention Hall, Atlantic City, N. J. Miss M. M. Kelley, secretary, 33 W. 39th St., New York, N. Y.*

**A.S.M.E. Oil and Gas Power Division**—*Annual Summer Meeting, Aug. 18–21, Penn State College, State College, Pa. C. E. Davies, secretary, 29 W. 39th St., New York, N. Y.*

**Chicago Exposition of Power & Mechanical Engineering**, *International Amphitheatre, Chicago, Ill., Oct. 4-9. Address Charles F. Roth, vice-president of International Exposition Co., Grand Central Palace New York, N. Y.*

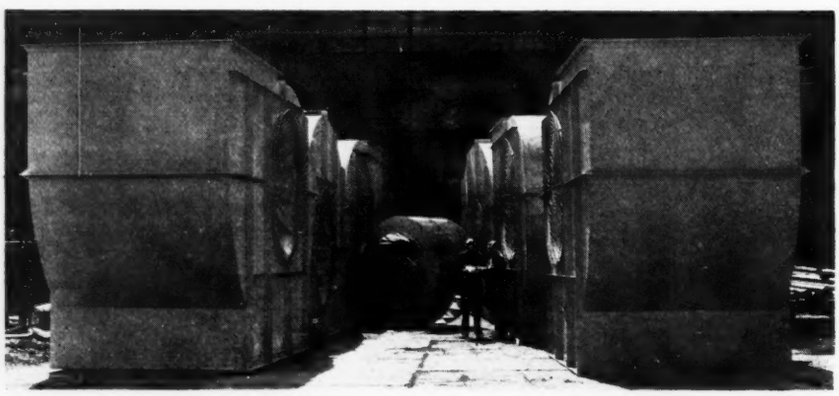
**Iron & Steel Exposition**—*Sponsored by Association of Iron and Steel Engineers, Sept. 28-Oct. 1, Hotel Stevens, Chicago, Ill.*

**National Association of Power Engineers**—*Mississippi Valley Mechanical & Electrical Show, and 55th Annual N.A.P.E. Convention, Aug. 30 to Sept. 3, Jefferson Hotel, St. Louis, Mo. Fred C. Laufketter, chairman of Executive Committee, N. A. P. E., in charge.*

**Universal Craftsman Council of Engineers**—*35th Annual Convention. Aug. 3-7, Stevens Hotel, Chicago, Ill. Exhibition of power equipment by 150 manufacturers in conjunction with convention. D. W. Haering, 3408 W. Monroe St., Chicago, Ill.*

**FANS FOR NEW YORK CITY'S NEW TUNNEL**

**SIX of the 36 Buffalo Forge Co. limit-load ventilating fans that will supply and exhaust air from the new Lincoln Vehicular Tunnel under the Hudson River at 39th St., New York City. Each fan weighs approximately ten tons. The 17 supply fans will handle a total of 3,218 cu.ft. of air per min.; the 19 exhaust fans will handle a total of 3,088,400 cu.ft. per min.**



## Work Progresses on State Line Generating Station

Chicago District Electric Co.'s State Line generating station, on the Indiana-Illinois state line between Hammond and South Chicago, is completing work on its 150,000-kw. No. 2 turbo-generator unit (3-cyl., tandem-compound, 1,800-r.p.m.).

It is the present intention to complete this project in two steps: (1) to install one standard and one reheat boiler and thus bring 100,000 kw. of capacity into commercial operation in the fall of 1937, and (2) at a later date a second standard boiler will be installed which will then bring the unit up to its total capacity of 150,000 kw.

The following structural and descriptive data were supplied by A. B. Clark of Sargent & Lundy, Inc.

Steam pressure at the turbine throttle is 1,200 lb. gage and temperature is 825 F. After passing through the high-pressure turbine, steam is reheated from about 600 to 825 F at a pressure of approximately 440 lb. abs. Vacuum at low-pressure turbine exhaust is 1.0 in. abs.

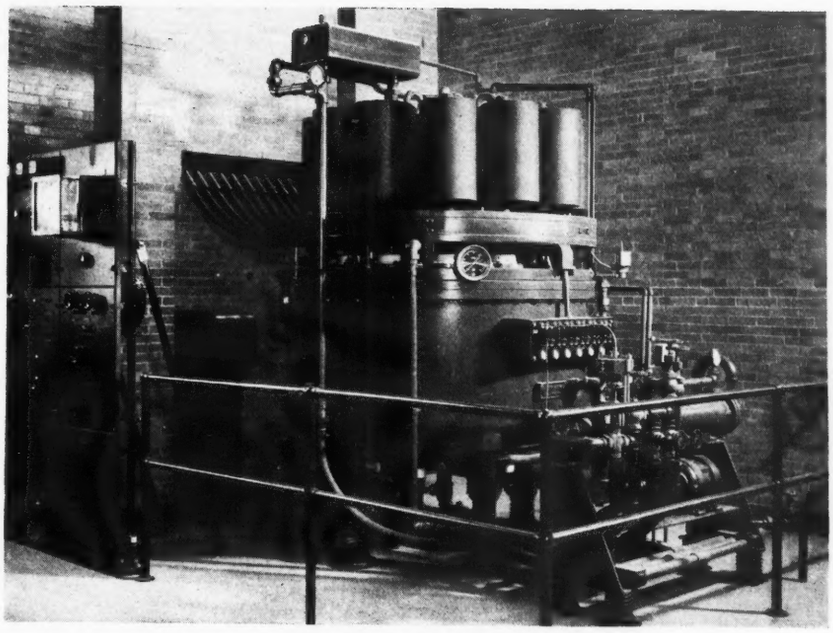
Feedwater-heating steam is extracted from the high-pressure turbine exhaust and at three other points at 132, 29 and 7.3 lb. abs. Final feedwater temperature is about 430 F. Total quantity of steam extracted is approximately 30% of throttle flow.

### Turbine Control

The turbine is protected from overspeed by the usual trip cylinder. This releases a latch on the throttle, operated by the emergency governor through an emergency trip valve which releases oil from the 30-lb. bearing line from below the trip cylinder. A vacuum trip valve, inserted in the oil circuit to the throttle trip cylinder, trips the throttle valve if vacuum fails. There is no automatic free-air exhaust valve on the condenser.

An intercepting valve has been placed in piping to the reheater close to the intermediate turbine. This valve is held open against a spring by oil pressure from the 100-lb. pressure line after oil passes through a pilot valve operated by the pre-emergency governor and a combined auxiliary dump cylinder and trip valve, as well as a vacuum trip valve. The intercepting valve is therefore closed by either the emergency governor or by loss of vacuum as well as by the pre-emergency governor. The pre-emergency governor allows the intercepting valve to begin closing as speed rises above normal and to open again when normal speed is restored. This does away with the usual time lag that occurs when the valve does not start to close until 10% overspeed has been reached, the case when the emergency governor alone is depended upon.

Steam is admitted to the turbine by primary, secondary and tertiary valves. On the primary valve, load is carried up to about 87,500 kw., and on secondary and tertiary valves, is carried up to about 116,000 and 150,000 kw. respectively. All admission valves are under control of the operating governor. Valves are closed by springs and opened by



**MERCURY-ARC RECTIFIER FOR D.C.**

**DIRECT-CURRENT supply, said to be for the first time in any steel and wire mill in America, is furnished by a 1,000-kw. mercury-arc rectifier for Republic Steel Corp.'s new wire mill in South Chicago. Automatic voltage control is provided by means of electrically energized grids, and the bus, a 9-in. copper channel ½ in. thick, is mounted on special insulators and steel beams in the upper part of the connecting tunnels beneath mill floors**

means of cams actuated by a hydraulic cylinder.

Should the vacuum tripping device fail, a breakable diaphragm, attached to each condenser, will rupture at a few lb. pressure above atmosphere.

The high-pressure turbine contains 16 impulse stages, as does the intermediate turbine, and the low-pressure turbine contains three stages arranged in two parallel steam paths back to back, steam entering in the center. Blading and nozzles are alloy steel; the cylinder casing is cast carbon-molybdenum steel where it is in contact with high-temperature steam.

The explosion-proof generator, 60-cycle and 2,200 volts, is hydrogen cooled. Suitable alarms are provided in case hydrogen pressure falls or rises between certain limits. Also, purity of the hydrogen is continually indicated and connected to the alarm system. Generator bearings are fitted with oil seals to prevent loss of hydrogen to the atmosphere, and means will be taken to free the sealing oil from hydrogen it may entrain.

## N.A.P.E. to Hold Convention and Power Show Aug. 30-Sept. 3

F. C. Laufketter, chief engineer of the Jefferson Hotel and general convention chairman of the 36th Annual N.A.P.E. Power Show, to be held at the Jefferson Hotel, St. Louis, Mo., Aug. 30 to Sept. 3, reports that only seven booths have not yet been reserved. The Power Show is being held in conjunction with the 55th Annual Convention of the N.A.P.E.

Communications concerning the Power Show should be addressed to Fred W. Raven, director of exhibits, Room 1717, 176 W. Adams St., Chicago, Ill.

## A.B.M.A. at Skytop

The American Boiler Manufacturers Association (and affiliated groups) held its 49th Annual Convention at Skytop Lodge, Skytop, Pa., June 6-9. A total registration of 112 made this the largest convention in A.B.M.A. history. Officers reelected included Starr H. Barnum (Bigelow Co.), president; W. F. Keenan, Jr. (Foster Wheeler Corp.), vice-president; A. C. Baker, secretary and treasurer.

Mornings were devoted to official business—afternoons to golf. Business sessions were private. Golfing laurels were won by the following: A. W. Strong, Jr., (Strong Scott Mfg. Co.), J. G. Eury (Henry Vogt. Machine Co.), C. O. Myers (National Board of Boiler and Pressure Vessel Inspectors), W. J. Sampson, Jr., (Republic Steel Corp.), and W. T. Conlon (Superheater Co.).

## Progress at Conners Creek

Boiler No. 12 at the Conners Creek Station of the Detroit Edison Co. will go into service this month. A drying-out fire was started about June 1, and the boiler is expected to be ready for operation about July 1. Installation of drums for new boiler No. 10 is in progress, and work has been started on reconditioning auxiliaries for 45,000-kw. low-pressure turbine No. 4.

## 75,000 kw. for Long Island

Long Island Lighting Co. has ordered a new 75,000-kw. turbo-generator for its Glenwood Landing station, which will bring rated capacity of the system's key generating plant to 170,000 kw. when it is placed in operation the latter part of next year. The turbine is being supplied by General Electric Co. and the condenser by Westinghouse Electric & Mfg. Co. Boiler pressure is to be 450 lb. and temperature 800 F. The turbine will be air cooled, 1,800 r.p.m., 13,200 volts, and directly connected to the generator. The unit will largely be a duplicate of the one last installed.

## Diesel Accessory Suppliers —A Correction

In the list of Diesel Plant Accessory and Supply Manufacturers, pages 338-340, June *Power*, Brown Instrument Co. should also have been listed under Analyzers, Exhaust Gas; Controllers, Temperature; Gages, Pressure; Indicators, Speed, Etc.; Instrument Panels, Engine; and Manometers. DeLaval Steam Turbine Co. should also have been included under Pumps, Cooling Water; Pumps, Oil Transfer; Blowers; Compressors, Air; Gearing; Speed Reducers and Increasers.

## OBITUARIES

CHARLES H. GIFFORD, 78, who was general manager many years ago of B. F. Sturtevant Co.'s plant at Boston, Mass., died at Bourndale, Mass., May 27. After leaving the Sturtevant organization, Mr. Gifford served for some years as vice-president and treasurer of American Blower Corp., and lately was treasurer of the Boston Port Development Co.

FRANK H. WILLARD, 71, president of Graton & Knight Mfg. Co., Worcester, Mass., died in that city May 25 after an illness of five weeks. In 1926 Mr. Willard was elected president, having been general manager for some years previous. He was a member of the board of trustees of Northeastern University and a director of the Worcester Trade School.

W. E. MILLER, mechanical superintendent, Bethlehem Steel Co., Johnstown, Pa., and a past president of the Association of Iron & Steel Engineers, died in Johnstown May 24.

WILLIAM FYFE TURNBULL, 55, instructor in mechanical engineering at Yale and New York Universities, died May 16 in Tuckahoe, N. Y. After graduating from Columbia, Mr. Turnbull served the city of New York for three years, and was in the employ of the Third Ave. Railroad Co. for six years. After his services as instructor at Yale University he went to New York University, where he served for 12 years.

HENRY W. DAGGETT, 58, former assistant general manager of the Bangor Hydro-Electric Co., died in Bangor, Me., May 12, after a long illness.

HOWELL A. SPENCER, 36, manager of the Twin State Gas & Electric Co. power stations in Alton and New Durham, N. H., died of pneumonia May 24 at his home in New Durham.

# STRAWS

*Pointing the way business winds blow*

**ARIZONA**——Bureau of Reclamation, Federal Bldg., Yuma, contracted Pleasant-Hasler Constr. Co., Luhrs Bldg., Phoenix, for construction of hydroelectric plant substructures at Drops 2 and 3, All-American Canal, Boulder Canyon Project, between Yuma and Calexico, Calif., at $410,496.50. Also awarded contract to Frank J. Kernan and John Klug, North Portland, Ore., for similar hydroelectric substructure at Drop 4, on canal, at $398,094.30.

Tombstone plans welded-steel pipeline for connection with natural-gas transmission pipeline of El Paso Natural Gas Co. Financing through Federal aid. Headman & Ferguson, Phoenix, Ariz., consulting engineers.

Arizona Citrus Growers, Inc., Jackson St., Phoenix, has approved plans for new 2-story and basement cold storage and refrigerating plant, 138 x 150 ft. Cost about $200,000, with belt-conveyor system.

**ARKANSAS**——Riley Feed Mfg. Co., Pine Bluff, is considering new boiler house in connection with rebuilding feed-milling plant partly destroyed by fire. Loss close to $75,000.

**CALIFORNIA**——Byron Jackson Co., Berkeley, plans power house at proposed new branch plant on Navigation Blvd., Houston, Tex. Cost about $450,000.

Surprise Valley Electrification Administration, Alturas, plans steam-electric generating station with initial capacity of about 900 kw. $500,000 through Federal aid.

Southern Counties Gas Co., 810 South Flower St., Los Angeles, plans extensions in properties at Orange, Calif., and vicinity to cost about $270,000, including new pipelines totaling 29,000 ft., of which 16,000 ft., will be 12¾-in. for main trunk lines, to cost $82,900; new service building to cost about $26,500; and regulators, meters and other service facilities, estimated at $125,000. In the San Pedro, Los Angeles harbor district, company will install about 19,000 ft. of new steel pipelines to cost close to $229,000.

Pacific Gas & Electric Co., 445 Sutter St., San Francisco, plans early construction of welded-steel pipelines from Rio Vista oil field district, Solano County, to Woodland, about 58 miles. Cost close to $900,000. Company also plans other welded-steel pipelines from same field to Suisun, Fairfield, Vicaville, and vicinity.

**FLORIDA**——Silver Springs Court, Ocala, C. Carmichael, proprietor, plans rebuilding of steam-electric power plant, recently destroyed by fire.

Fort Pierce has asked bids on general contract for addition to municipal power plant. Gilbert A. Youngberg & Associates, Lynch Bldg., Jacksonville, Fla., consulting engineers.

Jacksonville has asked bids for turbo-generator and auxiliaries, exciter set, surface condenser, etc., for municipal electric plant addition on Talleyrand Ave. Cost about $1,250,000. Taylor Eng. Co., Jacksonville, consulting engineer.

Marion County School Board, Ocala, plans central heating plant in new high school in Wyomina Crest district. Cost close to $400,000. Financing through Federal aid. Donald T. Mann, superintendent of board, in charge.

Merritt-Chapman & Scott Corp. has been awarded contract for a kraft paper pulp and board mill at Jacksonville, Fla., for National Container Corp. Cost about $3,260,000.

State Board of Control, Tallahassee, contracted H. B. Trauger, Lakeland, for boiler plant at Florida State Prison, Raiford, at cost of $31,000, exclusive of primary equipment. Robert & Co., Bona Allen Bldg., Atlanta, Ga., engineers.

**GEORGIA**——Atlanta plans expansion in waterworks and system, including motor-driven pumping machinery and auxiliaries, filtration and other mechanical equipment. Cost close to $1,000,000. Wiedeman & Singleton, Chandler Bldg., Atlanta, consulting engineers.

Board of Trustees, Atlanta University, Atlanta, contracted General Electric Co., for turbo-generators and accessories for new central powerhouse. Also, made award to Babcock & Wilcox Co., New York, N. Y., for boilers; to Seckinger Brothers Co., Atlanta, for steam pipelines; Alphons Custodis Chimney Construction Co., New York N. Y., for stack; and Barge-Thompson Co., Atlanta, for general construction. Lockwood, Greene Engineers, Inc., 30 Rockefeller Plaza, New York, N. Y., consulting engineer.

**IDAHO**——Federal Power Commission has granted license to Idaho Falls, for construction of a 5,000-hp. hydroelectric project on the North Fork of the Snake River at Upper Mesa Falls, Fremont County.

**ILLINOIS**——Cook County Board of Commissioners, Chicago, plans improvements in power house at county hospital at Wood and Harrison Sts., including four 7,500-sq.ft. boilers and auxiliary equipment, remodeling of two 5,000-sq.ft. existing boilers, and new gas and oil heat equipment. A new mechanical laundry will be built at institution, estimated to cost $374,000, with equipment. Fund of about $700,000 for project. Eric E. Hall, 123 West Madison St., Chicago, county architect.

St. Alexis Home of Alexian Brothers, 1200 Belden Ave., Chicago, plans new steam power house at institutional building at Signal Mountain, Tenn. Cost over $100,000. Herman J. Gaul, 228 East Superior St., Chicago, architect.

Refrigeration & Air-Conditioning Institute, 2154 Lawrence Ave., Chicago, plans new 2-story and basement addition to air-conditioning laboratory, totaling about 30,500 sq. ft. floor space. Equipment to cost about $150,000, exclusive of building, $100,000. Work to begin in August.

Palmer House, Chicago, last month took the first step in launching a $1,000,000 air-conditioning program, with immediate installation of a Carrier air-conditioning system for 160 rooms. The system will be extended subsequently to the entire hotel.

**INDIANA**——Decatur plans extensions in municipal power plant. Bids soon. Bevington-Williams, Inc., Indiana Pythian Bldg., Indianapolis, consulting engineer.

**IOWA**——Webster City receives bids until July 5 for extensions in municipal power plant, including one 2000-kw. condensing steam turbo-alternator with auxiliary equipment; one 30-kw. non-condensing steam turbine-driven exciter; one surface condenser, 3600 sq. ft., with auxiliaries; pipelines, fittings and complete auxiliary equipment. Cost about $110,000, exclusive of building. E. R. Compton, city manager.

Northern Natural Gas Co., Oakland, plans booster station for gas transmission line about 5 miles from Oakland, to include two 1000-hp. compressor units and auxiliaries. Cost over $200,000.

Traer plans early call for bids for water-softening plant for municipal waterworks. E. E. Schenck, Waterloo Bldg., Waterloo, consulting engineer. P. F. Stokes, secretary of municipal light & water department, in charge.

Primghar plans municipal power plant. Special election being arranged to vote $125,000 bonds. J. M. Metcalfe, town clerk.

Whiting has asked bids for improvements in municipal electric plant, including diesel-generator unit, exciter and auxiliaries. L. H. Wilen, town clerk.

Forest City contracted Busch-Sulzer for three or four diesels totaling 975 hp. Also, contracted L. A. Kepp Contracting Co., Rochester, Minn., for building. Entire project will cost about $165,000. Young & Stanley, Muscatine, consulting engineers.

Ackley contracted Fairbanks, Morse & Co., Chicago, for a 250-kw. diesel-generator set and accessory equipment. Ralph W. Gearhart, 341 21st st., S.E., Cedar Rapids, consulting engineer.

**KANSAS**——University of Kansas Hospitals, State House, Topeka, J. A. Mermis, business manager, plans extensions in steam power plant at institution at 39th St. and Rainbow Blvd., Kansas City. Cost about $68,000. Financing through Federal aid. Raymond A. Coolidge, State House, Topeka, state architect.

Lyons plans early call for bids for addition to ejector station for municipal sewage system. Charles A. Haskins & Co., Finance Bldg., Kansas City, Mo., consulting engineers.

**KENTUCKY**——Bourbon Distilling Co., Paris, care of Daniel E. Fowler, 408 Citizens' Bank Bldg., Lexington, plans boiler plant at new distillery on Ford Mill Pike, Paris. Cost close to $100,000. Work will begin this summer.

State Department of Welfare, Frankfort, plans power house at new Eastern State Hospital for Insane in Boyle and Mercer Counties. Entire project will cost $2,100,000. Associated Architects and Engineers for Department of Welfare, 417 High St., Frankfort, architects and engineers. C. R. Logan, Frankfort, engineer in charge.

**LOUISIANA**——Baton Rouge Electric Co., Baton Rouge, plans 10-in. welded-steel pipeline from Monte Sano gasfield area, about 5 miles, to point near Baton Rouge city limits, for natural-gas transmission. Cost close to $100,000.

United States Treasury Dept., has awarded contract to W. C. Spratt, Fredericksburg, for addition to power house at Marine Hospital, Carville, La., at $53,300. New equipment includes boiler and accessories.

United States Engineers Office, New Orleans, contracted Fairbanks, Morse & Co., Chicago, Ill., for two diesel-generators for use at Burrwood, La.

Opelousas contracted Busch-Sulzer for 1,000-kw. diesel-generator and auxiliaries for municipal electric plant, at $90,000.

**MASSACHUSETTS** —— Wellesley plans water-pumping station in vicinity of Weston Rd. Cost about $80,000 with motor-driven pumping machinery and auxiliary equipment. A. S. Cassidy, 544 Washington St., town engineer, in charge.

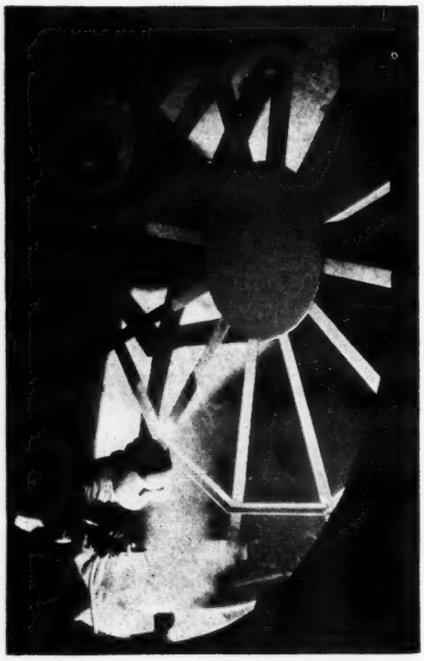
West Springfield has approved new pumping plant for water system. Cost over $35,000. McClintock & Craig, 458 Bridge St., Springfield, Mass., consulting engineers.

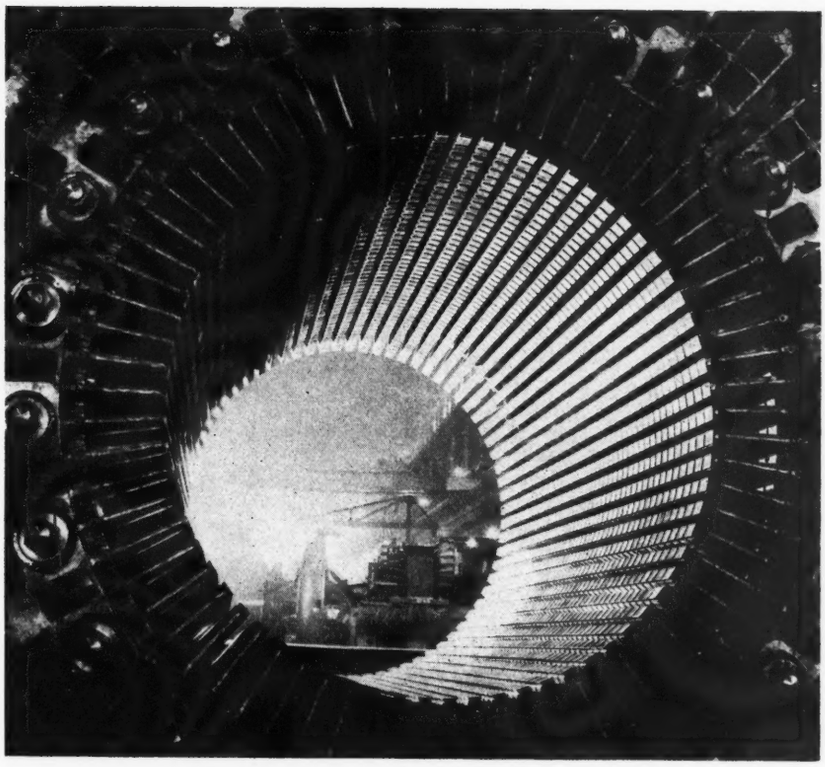
**MICHIGAN**——Washtenaw Gas Co., Ann Arbor, plans welded-steel pipeline from city limits to connection with trunk line of Panhandle-Eastern Pipe Line Co., Kansas City, Mo. A regulating and control station will be installed. Charles R. Henderson is president and general manager.

Engineering plans for a $300,000 power plant at Ubly, Mich., are being made by newly-formed Thumb Electric Co-Operative of Michigan, Frank Wilson, president.

Detroit contracted S. A. Healy Co., 351 West Woodbridge St., Detroit, for construction of pumping stations and grit

**A WELDER fuses steel to steel in the manufacture of an 11-ft. water-cooled shell of an automatic gas producer at Wellmann Engineering Co., Cleveland, Ohio. The shell of this gas producer is high-tensile, corrosion-resisting low-alloy steel known as "Cor-ten"—*Photo courtesy James F. Lincoln Arc Welding Foundation***





**TURBO-GENERATOR STATOR**

**A CLOSE-UP view of the stator for the 30,000-kw., 9,250-volt, 3-phase, 25-cycle, 95%-power factor, 1,500-r.p.m. turbo-generator unit now under construction at Allis-Chalmers' Milwaukee plant for the Fiske Street station of Commonwealth Edison Co.**

chambers for new municipal sewage disposal works, at price of $1,480,199.

Asselin Creamery Co., Iron Mountain, plans ice-manufacturing and refrigerating plant at Carpenter Ave, and West A St. Cost over $30,000. U. F. Asselin, president.

**MINNESOTA**——State Board of Control, St. Paul, contracted Standard Construction Co., 215 South Sixth St., Minneapolis, for new power house building and stack at State Hospital, Moose Lake, at $79,832, exclusive of equipment. Sund & Dunham, Essex Bldg., Minneapolis.

Detroit Lakes will take bids soon for extensions in municipal power plant, including turbo-generator, boiler and auxiliaries. Cost about $200,000. Foster & Wahlberg, Medical Arts Bldg., Duluth, consulting engineers.

Worthington is considering coal-storage unit at municipal power plant, with coal-handling machinery and auxiliary equipment. N. D. Miller, city clerk.

New Ulm has asked bids for boiler unit, stoker, mechanical fan and accessories for municipal electric plant. Ralph D. Thomas & Associates, 1200 Second Ave. S., Minneapolis, consulting engineers.

**MISSOURI**——Vilter Mfg. Co., Milwaukee, Wis., has obtained a contract at $120,000 for air-conditioning the Sears-Roebuck store in Kansas City.

Dr. Frank Demko, 1319 South Broadway, St. Louis, is at head of project to construct and operate new fruit-canning plant on State Highway 55, near Altoona, Fla., to include boiler house and pumping station. Cost over $50,000.

**MONTANA**——Great Falls plans additional motor-driven pumping machinery and auxiliary equipment for water system in Sun River Park area. Bids will be asked soon. Cost about $30,000.

**NEW HAMPSHIRE**——Public Service Co. of New Hampshire has purchased the northern division steam plant of Amoskeag Mfg. Co., in Manchester, and will remodel the plant to make it a supplementary power producer for the company's hydro-electric plant a few hundred feet further up the Merrimack River.

**NEW YORK**——Phelps Dodge Copper Products Corp. has placed contracts with Stone & Webster Engineering Co., as engineers and Austin Co. as general contractors for erection at Yonkers of an addition to the plant of its Habirshaw Cable & Wire Division.

**NORTH CAROLINA**——Tidewater Power Co., Wilmington, contracted Edge Moor Iron Works, Edge Moor, Del., for 8,130-sq. ft. boiler for local steam-electric generating station, replacing two present smaller boilers.

**NORTH DAKOTA**——Mandan plans filtration plant for municipal waterworks. Cost close to $170,000.

**OHIO**——Salem Fruit Growers' Cooperative Assn., Greenford, plans 2-story cold storage and refrigerating plant, 60 x 100 ft., with adjoining smaller unit. Cost close to $60,000.

St. Mary's plans extensions in municipal power plant. Cost about $60,000. Bado Hoewischer, municipal service director.

Columbus Grove plans improvements in municipal power plant. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Warren plans early call for bids for new water-softening plant for municipal waterworks station. Cost close to $90,000.

**OKLAHOMA**——Oklahoma Natural Gas Co., has awarded contract for 20 miles of 10-in. and 18 miles of 8-in. gas lines to White Deer Pipe Line Construction Co. The Lindewelded line will run from Enid to Crescent, Okla.

Skelly Oil Co., Tulsa, plans battery of seven 80-hp. engines for compressor service and auxiliary equipment. Cost over $200,000, including pipeline.

Cities Service Gas Co., Bartlesville, a subsidiary of Cities Service Co., 60 Wall St., New York, N. Y., plans welded-steel pipeline from point in Seminole County, where connection will be made with existing system, to natural gasoline plant of Carter Oil Co., near Ada. Cost close to $400,000.

Great Lakes Pipe Line Co., Tulsa, plans 8-in. welded-steel pipeline from Barnsdall to Kansas City, Mo., paralleling an existing pipeline between these two points; 6-in. welded-steel pipeline from Des Moines, Iowa, to St. Paul and Minneapolis, Minn., about 210 miles; and new 6-in. similar steel pipeline from Osceola, Iowa, to Omaha, Neb. Cost over $2,000,000.

Ketcham Hotel, South Main St., Tulsa. H. E. Ketcham, head, is considering installation of a complete air-conditioning system in 8-story hotel.

**OREGON**——State Board of Control, Salem, plans steam power house at Eastern Oregon Tuberculosis Hospital, The Dalles, for central-heating service. A new mechanical laundry also will be built. Fund of $120,000 authorized for this and other expansion. Jones & Marsh, Woodlark Bldg., Portland, Ore., architects.

**PENNSYLVANIA**——Reading has surveys and estimates of cost under way for proposed municipal light and power plant. Tentative cost reported at $2,500,000, with equipment. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineers, in charge.

**SOUTH DAKOTA**——Martin plans extensions in municipal electric plant, including 200-hp. diesel-generator unit and auxiliaries. Similar expansion will be carried out at municipal ice plant, including refrigerating unit, tank, etc.

Freeman plans municipal electric plant distributing system. Cost close to $75,000. Financing being arranged. Buell & Winter Engrg. Co., Insurance Exchange Bldg., Sioux City, Iowa, consulting engineer.

**TEXAS**——Southern Methodist University, Dallas, plans central-heating and air-conditioning systems in new library building. Cost about $450,000.

John A. Hastings, Brownsville, and associates plan welded-steel pipelines from oil field area in Zapata, Hidalgo and Starr Counties to Brownsville, about 150 miles. Cost over $1,000,000 with booster pumping stations. Work under way soon.

Hidalgo Gas Co., McAllen, plans welded-steel pipeline from connection with main pipeline system, vicinity of McAllen, to Mercedes, Donna and neighboring points, for natural-gas transmission. Cost over $80,000.

H. O. Wooten, Abilene, has acquired property at 706 Texas St., Lubbock, Tex., as site for new 2-story cold storage and refrigerating plant, 50 x 115 ft., for which superstructure will begin soon. Cost about $40,000, with equipment.

Public Service Corporation of Texas, Fort Worth, plans welded-steel pipeline for natural-gas transmission to Lampassas, Llano, San Saba and neighboring communities. Pipeline systems will be installed in different municipalities for distribution. Entire project will cost about $350,000. Work will be carried out during summer.

Independent School District, Anahuac, plans central heating plant in new 2-story high school. Erection will begin this summer. Cost about $200,000. Cornell G. Curtis, 300 West Nineteenth St., Austin, architect.

O'Hern Pipe Line Co., Corpus Christi, affiliated with Corpus Christi Crude Oil Co., same place, plans 4-in. welded-steel pipeline from Government Wells oil field district, Duval County, Tex., to O'Hern oil field area, Webb County, Tex., about 33 miles. Cost over $200,000.

Board of Port Commissioners, Brownsville, F. W. Hofmoke, port director, plans pre-cooling plant on waterfront, with capacity for 100 carloads of fruits and vegetables. Cost close to $100,000.

Menard plans early installation of new butane gas plant for municipal service. Bond issue of $35,000 has been approved.

Sulphur Springs contracted Brown & Root, Inc., 708 Colorado St., Austin, for construction of municipal electric plant and distribution system. $200,000 arranged for project. Municipal Eng. & Finance Co., Mercantile Bldg., Dallas, consulting engineer.

Dallas Athletic Club, Dallas, contracted Baker Ice Machine Co., Omaha, Neb., for air-conditioning plant and system for first three floors of club building, at $37,500.

**UTAH**——Mountain Fuel & Supply Co., 36 South State St., Salt Lake City. O. D. Donnell, president, plans 10-in. welded-steel pipeline from point near Rock Springs, Wyo., to connection with main pipe line to Salt Lake City, about 21 miles. Cost close to $350,000.

# LICK AND PROMISE . . .

I remember in one machine shop they had a lathe hand called "Snow Ball." He wasn't a gentleman of color either, but you couldn't tell it five minutes after he got to work in the morning. "Snow Ball" ran a roughing lathe on cast iron, and if you've ever turned cast iron, you know how dirty the shavings are. But that doesn't mean you have to swim in the dust. That was Snow Ball's trouble—he'd get his hands in the cast-iron dust, then all over his overalls and his face. He couldn't have gotten dirtier in a coal mine.

Funny thing, too—"Snow Ball" never got beyond that roughing lathe. He had enough ability to rough out cast iron, but he wasn't good enough to graduate to a fine-machining job. Somehow, lack of skill went with his dirtiness. You'll find that's usually true. Find a dirty shop, and you'll find a second-rate boss; find a dirty power plant, and you'll find a poor engineer.

It doesn't follow that any engineer that keeps his plant clean is a good engineer, but the chances are good. As his men clean up that corner, they take away a chance for fire. As they clean off that pipeline, they find the little leak that some day may be a big one. As they shine up that pump they find the small score that eventually will grow bigger and rip out the packing. Cleaning up around the engine, they find the loose oil cup that's due to fall off, and they hear the little rattle that will some day be a knock. In addition to cleaning, they're unconsciously inspecting, finding the little troubles that uncaught grow to big ones.

Some smart man said a long time ago, "Fix all the little troubles, and you'll never have any big ones." A little trouble that's noticed is half fixed —it's the troubles that nobody notices that really raise the devil.

Sounds a little far-fetched, but it isn't. Check for yourself. In a clean plant, there's less trouble, not only because they find and fix the little things, but because each man in a clean plant works better. If you have a "Snow Ball," hand him a broom and see that he uses it. A lick-and-promise cleaning only fools the cleaner.

George Edwards

GEORGE EDWARDS,
*Engineer*

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Thinking industrials do not stumble into this costly error. They insist on proven Motor Control for motors of every size. That is why Cutler-Hammer Bul. 9586 Motor Control is so widely preferred for the smaller motors of Industry. Its many features of superior construction, its legacy of the widest engineering experience and its unequalled record of performance *must* recommend it to you. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1358 St. Paul Avenue, Milwaukee, Wisconsin.

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## NEW BULLETINS

**Diesel Engine**—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. 4-page folder describes new Model 42-E designed as a heavy-duty, continuous service stationary engine. 2- or 3-cyl., 60 or 90 hp., 450 r.p.m., 8¾-in. bore, 10½-in. stroke.

**Pumps**—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago. Bulletin 6150 on self-oiling power pumps for pressures up to 300 lb. per sq.in. Either belt- or motor-driven units. Tables on sizes, ratings, and dimensions.

**Centrifugal Pumps**—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago. 4-page illustrated Bulletin 5870 describes pumps for heads up to 245 ft. and with capacities from 90 to 225 gal. per min.

**Belt Conveyors**—Chain Belt Co., 1600 West Bruce St., Milwaukee, Wis. 114-page illustrated Catalog 270 contains design and application information on belt conveyors for handling bulk materials, with listings and descriptions of belt-conveyor equipment. Charts, tables and dimension drawings provide quick selection for particular requirements.

**Electric Heaters**—Elliott Co., Jeannette, Pa. Two bulletins on heating equipment for the process industry. Bulletin M-1 describes indirect electric system for industrial heating by hot circulating oil, immersion heaters, and tubular heaters for temperatures up to 2000 F. and pressures of 1500 lb. or more. Bulletin M-2 covers continuous deodorizing system for edible and industrial oils, using electric heaters.

**Arc Welders**—Hobart Bros., Troy, Ohio. Mailing folder on portable and stationary welding units, either gasoline-engine or electric driven.

**Generators and Motors**—Elliott Co., Jeannette, Pa. 24-page pictorial bulletin No. L-6 shows typical installations and applications. Well illustrated.

**Air-Conditioning Equipment**—Trane Co., La Crosse, Wis. New house organ, "Weather Magic" shows new Trane air-conditioning equipment and applications. Vol. 1, No. 1, published in April, 1937.

**Gas Indicator**—Mine Safety Appliances Co., Braddock, Thomas and Meade Aves., Pittsburgh, Pa. Mailing folder describes a portable unit for testing explosive gas hazards and locating gas leaks. Illustrations and operating diagram.

**Gas Engines**—Joseph Reid Gas Engine Co., Oil City, Pa. 40-page Catalog No. 40 describes 2-cycle Type A gas engine. Catalog also contains information on pumping powers, reverse rigs and other oil-field equipment.

**Centrifugal Pumps**—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Information on single-unit, electric-motor driven centrifugal pumps for capacities up to 1,000 gal. per min. and heads to 500 ft. Motor sizes range from ¼ to 40 hp.

**Feedwater Conditioning**—Permutit Co., 330 West 42nd St., New York, N. Y. Very complete 68-page booklet on zeolite process for treating boiler feedwater. Zeolite manufacturing process, latest equipment, control, analyses and requirements are all described. Includes many halftones and detailed drawings.

**Air-Conditioning Water Economizer**—York Ice Machinery Corp., York, Pa. 8-page Bulletin No. 36282 describes self-contained, combined forced-draft cooling tower and refrigerant condenser for either outdoor or indoor installation. Said to save about 99% of water normally required for condensing purposes.

**Refrigerating-Machinery Oil**—York Ice Machinery Corp., York, Pa. Folder No. 37305 on lubricants refined and purified for requirements of refrigerating machinery.

**Valves and Fittings**—Walworth Co., 60 East 42nd St., New York, N. Y. First issue "Walworth Today", 12-page bi-monthly house organ, published in May. Contains illustrations of new developments, and articles on laboratory technique and the part it plays in anticipating tomorrow's needs. Copies mailed on request.

**Temperature Control**—Wheelco Instruments Co., 1929 S. Halstead St., Chicago, Ill. Bulletin 601, "Data on Temperature Indication and Control", describes new type automatic electric control based on "radio principle." Shows construction and application. Also includes various pyrometers and flame indicators. Sizes and capacity tables.

# NEW PLANT CONSTRUCTION

*McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service*

**Conn., West Hartford**—Hartford Electric Light Co., 266 Pearl St., Hartford, plans 25x30 ft. power sub-station, Albany Ave. near North Main St. To exceed $40,000. Private plans.

**Fla., Orlando**—Bids June 21, by Orlando Utilities Comn., 10,000 kilowatt turbine generator for power plant. $600,000-$700,000.

**Ill., Chicago**—Cook County Hospital, c/o Bd. Comrs., Cook Co., Wood and Harrison Sts., plans by E. Hall, 123 West Madison St., and takes bids in June constructing laundry building, 2 underground subways, four 750 hp. boilers in power house, etc., at hospital. $700,000.

**Ind., Indianapolis**—International Harvester Co., S. G. McAllister, pres., soon takes bids plant for manufacturing auto truck engines (main unit 340,000 sq. ft. floor space), central heating plant, electric power plant and power sub-station, Brookville Rd., Whittier and Arlington Ave. and Pennsylvania R. R. $4,000,000. Private plans.

**Ind., Washington**—Bd. P. Wks. soon takes bids super heater for 412 hp. Sterling water tube boiler for municipal power plant. Bevington-Williams, 1139 Indiana Pythian Bldg., Indianapolis, engrs.

**Ia., Allison**—Butler County Rural Electric Co-Operative soon takes bids constructing rural electric generator project. $105,000. REA approved project.

**Ia., Oakland**—Northern Natural Gas Co., 1515 City Natl. Bank Bldg., Omaha, Neb., constructing booster station and installing two 1,000 hp. compressor units, own forces. $175,000. Private plans.

**Ia., Primghar**—City plans constructing municipal light and power plant. $125,000 authorized at special election. J. M. Metcalf, city clk.

**Ia., Ventura**—Northern National Gas Co., 1515 City Natl. Bank Bldg., Omaha, Neb., plans brick booster station and installing 3 Cooper-Bessemer gas engines. $150,000. Private plans.

**Ia., Webster City**—Bids July 5, by City Council, constructing 1 story, basement, municipal electric light and power plant addition, $22,000; also for equipment to consist of one 2,000 kw. condensing steam turbo-alternator unit, and appurtenances, one 30 kw. non-condensing steam turbine driven exciter and appurtenances, one 3,600 sq. ft. surface condenser with auxiliaries and appurtenances for 2,000 kw. steam turbo-alternator unit, pipes, fittings, pig lead, oakum. $110,500. R. W. Youlden, City engr.

**Kan., Kansas City**—City, C. Lowder, Bd. P. Utilities, City Hall, plans installing new substation at 29th St. and Leavenworth Interurban tracks. $65,000. Improvements and lines will be in addition to estimate.

**Kan., Moundridge** — Continental Oil Co. made final plans 800 kw. gas electric plant using three 400 h.p. units. $75,000.

**Mass., Peabody**—City, P. H. Tumelty, mgr., Electric Light Dpt., preliminary survey municipal electric lighting plant. To exceed $40,000. Private plans.

**Mo., Koch**—City of St. Louis, c/o Baxter L. Brown, pres. Bd. Pub. Serv., 304 City Hall, St. Louis, appropriation approved by Bd. Estimate & Apportionment, power plant equipment and ward building equipment for Koch Hospital. $150,000. W. C. E. Becker, 301 City Hall, St. Louis, engr.

**Mo., Marshall**—City soon takes bids furnishing, installing power plant pumps and auxiliaries for city-owned light plant. $33,000. Henrici-Lowry, 1140 West 10th St., Kansas City, Mo., engrs.

**Mo., Rockport**—City, J. Welch, mayor, election soon to vote bonds, constructing new power plant and distribution system. To exceed $100,000. Engineering Service Co., Railway Exch. Bldg., Kansas City, Mo., engr.

**Neb., Havelock** — Chicago, Burlington & Quincy R.R. Co., A. W. Newton, ch. engr., 547 West Jackson Blvd., Chicago, Ill., plans alterations and improvements to power plant, so as to make use of sawmill shavings for fuel. $35,000.

**N. H., Rochester** and **Amoskeag Falls** — Public Serv. Co. of New Hampshire, modernizing steam electric power plant. Separate contracts. To exceed $50,000 with equipment.

**N. J., Camden**—Camden City Comn., City Hall, proposed municipal light, heat and power plant. Est. $10,000,000. State Supreme Court ruled against project for second time on grounds that Camden would exceed its legal debt limit if project were undertaken.

**N. Y., Penn Yan**—Municipal Bd. plans purchasing and installing 2,000 kw. steam turbo-generating unit at municipal light and power plant. **Maturity soon.** H. A. Wagener, pres.

**N. C., Ocracoke**—Ocracoke Power & Light Co. plans 14 mi. lines to serve 151 customers. $15,000 and generating plant $25,000. R. Williams and R. W. Howard, Ocracoke, incorporators. Entire project financed by Federal grant.

**N. D., Walhalla**—City plans constructing complete municipal electric power plant. $58,000 bonds voted May 4. E. L. Lium, Grand Forks, engr.

**O., Cleveland**—City, C. B. Patterson, purch. agt., plans municipal light plant, 50,000 kw. turbines, St. Clair Ave. and Chardon Rd. $15,000,000. Will apply for W.P.A. funds. L. O. Quayle, City Hall, engr.

**O., Columbus Grove**—Bd. Pub. Affairs retained Burns & McDonnell, engrs., 307 East 4th St., Cincinnati, to make survey of equipment of municipal light and power plant with view to expanding facilities and increasing power production.

**O., Painesville**—Bids June 17, by Wilbur Watson & Associates, engrs. and archts., 4614 Prospect Ave., Cleveland, constructing 3 and 4 story, 80x320 ft. factory, three 1 story 320x450 ft., 280x350 ft. and 60x600 ft. factory buildings, 2 story, 40x250 ft. office building, 2 story, 130x170 ft., power house and water condition building, for Industrial Rayon Corp., J. P. McGervey, purch. agt., West 98th and Walford St., Cleveland. Est. $3,500,000.

**Okla., Oklahoma City**—Oklahoma Gas & Electric Co., 321 North Harvey St., made final plans constructing 2,000 k.v.a. substation, Southwest 22nd St. and Pennsylvania St. $25,000. Byllesby Eng. Co., 231 South LaSalle St., Chicago, Ill., engrs.

**Pa., Mt. Gretna**—State Dpt. Welfare, Harrisburg, plans by Hornbostel & Clayton Lapley, Harrisburg, construction prison buildings to include power plant on 18 acre site. Total est. $2,000,000.

**Pa., Newtown**—George School, Newtown, plans 1 story, basement, 32x70 ft. power plant and laundry, pumphouse, 275 ft. tunnel, etc. G. Kendrick Bringhurst, 1700 Walnut St., Phila., consulting engr. Noted May 26, C.D.

**Pa., Pittsburgh**—Jones & Laughlin Steel Corp., F. W. Ochsenhirt, purch. agt., 2 story, 48x50 ft., brick, steel power plant, concrete found., day labor. Owner buys materials. Private plans.

**Pa., Reading**—Metropolitan Edison Co., Reading, or c/o Associated Gas & Electric Co., 61 Bway., New York, plans addition to electric power plant. $3,000,000.

**Pa., Reading**—City Council retained Burns & McDonnell, Eng. Co., engrs., 107 West Linwood Blvd., Kansas City, Mo., to make 4 month survey on feasibility of building municipal electric light and power plant. May vote on bond issue for project at November election. C. V. Webber, city engr.

**R. I., Providence**—Narragansett Electric Co., 49 Westminster St., plans by United Engineers & Contractors, Inc., E. H. Keenan, 1401 Arch St., Phila., Pa., brick, steel, concrete steam generating electric power plant. $2,000,000.

**S. D., Cheyenne Agency**—Bids June 17, by Dpt. Interior, constructing power plant and equipment with accessories, at Cheyenne River Agency.

**S. D., Freeman**—City plans power plant and power distribution, $72,000. Soon sets date for special election. Buell & Winters Eng. Co., Sioux City, Ia., engrs.

**Tex., Jacksonville**—City c/o Secretary, plans election to vote $250,000 bonds for constructing municipal power and light plant.

**Utah, Orderville**—Orderville Power & Light Co. plans hydro-electric plant at Glendale, and an emergency steam plant at Orderville to furnish electricity for light and power to towns of Glendale, Orderville, Alton, Mt. Carmel and Mt. Carmel Junction. Application filed with State Utilities Comn., for certificate of convenience and necessity.

**Utah, Salt Lake City**—Denver & Rio Grande Western R. R. Co., A. O. Ridgway, ch. engr., Equitable Bldg., Denver, Colo., constructing modern 1800 hp. steam power plant, by force account. Contract for installing three 600 hp. boilers to J. J. Burke & Co., Kearns Bldg. Est. $250,000. D. Van Law, Salt Lake City, combustion engr. for installation of equipment.

**Vt., Hardwick**—Village, Electric Department, plans being completed by Charles T. Main, Inc., 201 Devonshire St., Boston, Mass., altering old building and making power equipment installations.

**Wis., Madison** — Madison Gas & Electric Co., 100 North Fairfield St., plans by Mead, Ware & Hunt, 115 South Carroll St., constructing electric generating plant addition.

**Wyo., Laramie**—Western Pub. Serv. Co. plans enlarging power plant adding 1,500 kw. generator unit to present plant.

**W. Va., Wheeling**—Wheeling Electric Co., 51 16th St., plans electric power sub-station. $250,000.

**B. C., Castlegar**—West Kootenay Power & Light Co., Ltd., L. A. Campbell, vice pres. and genl. mgr., West Kootenay, soon takes bids constructing hydro-electric plant consisting three 18,000 hp. vertical units. $4,000,000.